POWER

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Spirit of Progress

Lest it be thought these buyer and seller forewords are written too much from one side and that there are no good purchasing agents, let me say this:

There are few businesses today whose early buying practices have not undergone revision for the better. It is recognition of the viciousness of some of the older practices on both sides and the need for reform which have built the code of purchasing ethics so carefully adhered to in so many places today.

All credit to those whose sense of responsibility and knowledge of sound buying do not permit them to be made the target of unsound competitive practices. Cases are increasing in number where buyers have refused to accept the bids of sellers who offer to build to their competitors' specifications at lower prices; or who make cheaper quotations on apparatus copied from renowned leaders in the field who maintain expensive personnels in order to build better and more advanced equipment.

Operating companies realize more and more the advantages to themselves from a buying policy which gives protection to those sellers who not only sell but cooperate with the buyer and keep abreast of his ever changing needs.

This mutual helpfulness is the true spirit of progress.

EDITORIALS

Encouraging the Use Of Natural Gas

During the past year thousands of miles of pipe lines have been constructed, so that now a supply of natural gas is available to much of the country. The capacity factors of these lines are not attractively high and the problem of the utilities is to build up greater loads. Up to the present, stress has been laid upon the advantages of gas for industrial process loads, while in some localities the rates are such that gas cannot be economically burned under boilers or used in gas engines. In fact, in one. Western state the rates are influenced, in a measure, by the nature of the application, with the result that one burning gas in an engine pays a higher rate than does a neighboring plant where an equal amount is being used under boilers.

If it is intended to create a demand for this product the gas utilities would do well to consider the feasibility of eliminating the use-factor in rate-making and, if it be possible, lower the rates on such blocks of gas as might be reasonably burned in boiler and gas-engine plants of modest capacity. With pipe lines operating at less than fifty per cent capacity, there should be an advantage to both buyer and seller if promotional rates were inaugurated.

Low-Temperature Carbonization

A few years ago keen interest was shown in the low-temperature carbonization of coal. American engineers were sent to Europe to study every new development there. Large sums of money were spent here upon research and on semi-commercial plants to try out those processes which appeared promising in the laboratories. Some plants of commercial size were built to operate in connection with power stations or gas works. Hopes were entertained that the revenue from the sale of the low-temperature byproducts would prove profitable and that the employment of these processes would at the same time lower the costs of producing electricity and gas.

Yet at the International Bituminous Coal Conference in Pittsburgh a few weeks ago the consensus of opinion was that low-temperature carbonization had little economic justification at present in America. Why has this change of attitude occurred and is this change permanent or temporary?

The situation here is different from that abroad. Low coal prices resulting from demoralization of the coal trade have lessened the interest in products derived from its decomposition. The abundant supply of natural gas and petroleum products at unprecedentedly low prices eliminates any possible profit from the production of motor fuels from coal. Since tar is only in normal demand for chemical purposes, its price in America is regulated by the price of fuel oil, and it cannot economically be produced at present petroleum prices. Finally, the price of low-temperature coke is governed by that of coal.

One hesitates to express an opinion on future possibilities of such processes in America. So many false predictions have been made as to the probable exhaustion of our petroleum supplies that forecasts are useless. But in view of the present conditions concerning coal, oil and gas there is little opportunity for low-temperature carbonization, as an adjunct to American power stations, in the immediate future.

Motor Load Tests Prevent Breakdowns

A motor is something like a human being; it may have a healthy appearance, but all may not be well on the inside, or conditions under which it is working may be such as to cause a breakdown, unless corrected. For this reason load and other check examinations should be made periodically. Experience has shown that meter tests on motors are practically imperative if efficient and trouble-free operation is to be obtained. There are plenty of plants in which costly failures were frequent occurrences. By adopting a systematic maintenance program and periodically taking meter readings of motors, serious trouble has been eliminated.

Because a motor does not run hot is no reason for not making a load test. Wear or other causes may materially increase the power required to operate a machine. If the machine happens to be overmotored, there may be no external evidence that the power demand has increased and this will continue until breakdown unless a load test is made. Under these conditions the increased power cost could have been saved easily had the cause been known. Sometimes increased power input to a motor may indicate the development of conditions in the driven machine that will cause expensive repairs unless corrected. By a proper system of meter readings, costly machine repairs and interruptions to production can be avoided to an amazing extent.

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POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

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Oxidation Characteristics of Turbine Oil

A laboratory test to determine the oxidation characteristics of turbine oils is described, and the results of tests with it are correlated to oil characteristics as found in actual service

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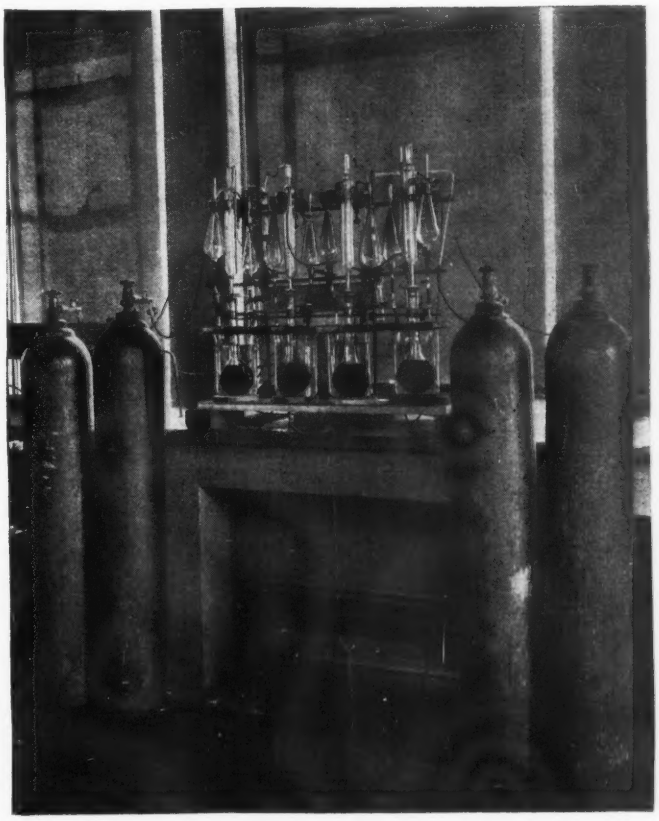

Fig. 1—Apparatus assembled for oxidation test

IT HAS BEEN observed that as soon as new turbine oil is put into service undesirable changes begin to take place within the oil. These changes are brought about by oxidation, and manifest themselves chiefly as sludge and an oil-water emulsion in the oil. Both sludge and emulsions tend to clog the oil circulating systems if they develop in appreciable quantities. This oxidation in service is brought about chiefly by the action of atmospheric oxygen aided by heat and moisture, and results in the successive formation of alcohols, aldehydes, acids and asphaltenes. A portion of the acids and asphaltenes precipitate out, forming the familiar brown sludge. The oxidation products which do not separate out tend to cause the oil to form stable emulsions if it comes in contact with water.

The results of the usual tests, such as specific gravity, flash and fire, viscosity, acidity and steam emulsion, when applied to new turbine oils, indicate their suitability for turbine use, and also give some idea of the degree of refinement, but they do not indicate adequately what may be expected from the oil in service from the standpoint of its tendency to oxidize. Many investigators have directed their efforts toward devising tests to determine the quality of turbine oil as measured by the oxidation characteristics. The many tests of this nature which have been advocated fall into two classes, namely, short-time oxidation tests and long-time oxidation tests.

The use of the short-time tests to determine the quality of turbine oil is not advocated at this time, because it has not been established definitely whether the results obtained in this type of test are comparable with the results obtained in service. It is felt that, before a short-time oxidation test capable of adequately indicating the qualities of turbine oil can be developed, a systematic study of the changes occurring during service should be made. Recent studies by such investigators as N. E. Funk, of the Philadelphia Electric Company, and T. H. Rogers, of the Standard Oil Company, of Indiana, have shown that, at present, oxidation tests of from fifty to five hundred hours duration give a better insight into the changes occurring in the oil in service than do the short-time tests. Short-time tests may serve as adequate acceptance tests for turbine oil, however, when sufficient studies have been made to correlate the results obtained by them with those obtained from oils in service.

The conditions to which the oil is subjected in long-time oxidation tests are not believed to be as severe as those in the short-time tests, and consequently better duplicate, yet accelerate, those conditions encountered in service.

The study of one such test has indicated that, although it was not satisfactory as an acceptance test, because of the length of time required to carry it out, it appeared to serve well as a means of distinguishing oils of relatively poor quality from those of better quality, and in a certain measure produced results, so far as oxidation products were concerned, similar to those developed in the oil during actual use. The apparatus used in this study is shown in Fig. 2. It consists of a 500-c.c. flask *a*, fitted at the top with a water condenser *b*. The flask is placed in a beaker of water *c*, maintained at a temperature of 212 deg. F. by means of an electric heater *d*. The glass tube *e*, which extends to the bottom of the sample flask, is used to bubble oxygen through the oil.

The water bath is loosely covered by a plate *f* to aid in the maintenance of a constant temperature. Fig. 2 illustrates the apparatus used for the test. The curtains shown in the picture were drawn only to aid the photographer in lighting the equipment.

A three-foot length of No. 16, B. & S. gage, iron wire in the form of a coil was introduced into the flask, together with a 500-c.c. sample of the oil. The temperature of the water bath was then raised to 212 deg.

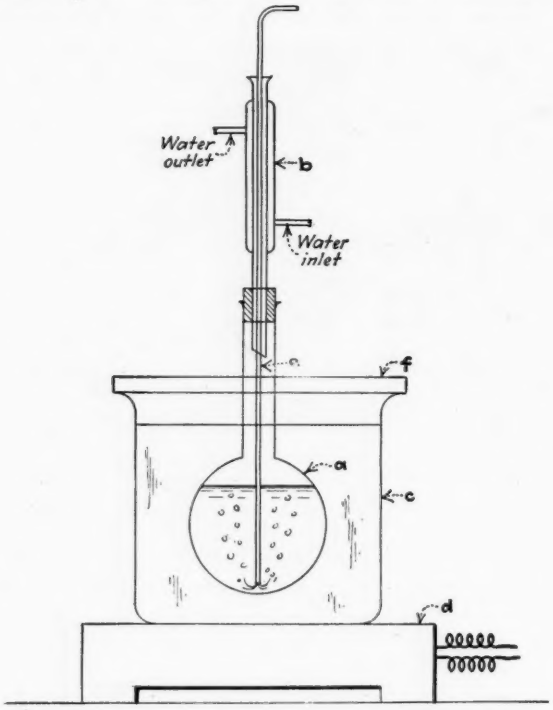

Fig. 2—Diagram of apparatus used in oxidation test

The level of the water in the bath was automatically held constant by a system of syphons and the temperature was kept uniform throughout the test. Oxygen was then bubbled, first through a wash bottle filled with distilled water and then into the samples at a rate of two bubbles per second. At twenty-four-hour intervals 10-c.c. samples were removed from the main body of oil, centrifuged at 1,000 r.p.m. for one-half hour, and filtered to determine the amount of sludge formed. The oil was then tested for acidity by the standard A.S.T.M. method.

This oxidation test is similar to the Rogers stability test. The chief points of difference between the two tests are: first, the introduction of a condenser by means of which all condensable oxidation products, volatile at the temperature of the test, are returned to the main body of the oil; second, the use of a transparent water bath, exposing the sample under test to sunlight coming through the west windows of the laboratory. The light serves to further accelerate the oxidation of the oil.

Samples of turbine oil representing twelve brands available in the current market were tested for their relative oxidation characteristics by the method outlined above. These oils were represented by their respective vendors as being oils of excellent quality for turbine use. The ordinary characteristics of these samples are shown in Table I.

Curves showing the development of acidity and sludge during this oxidation test are shown in Figs. 3 and 4, respectively. These curves represent the average trend of these characteristics and were obtained from original curves by means of a planimeter and mathematical calculation. Table II gives the viscosity, A.S.T.M. steam emulsion number, and acidity, both before and after the oils were subjected to this oxidation test.

In the past it has been common opinion that only paraffin-base crude oils yielded turbine oils of good quality. Samples 6, 8, and 12, which are noted in Fig. 4 as developing no measurable quantity of sludge, were refined from asphalt crudes. It should also be noted that these oils stood up well in the oxidation test. From this it is evident that a paraffin-base oil may not be as resistant to oxidation as an oil refined from a crude of asphaltic origin.

Although, in general, the rate of acidity change was found to be in inverse ratio to the cost per gallon, this is not true in the case of samples No. 7 and 12, which appeared to be oils of outstanding quality, considering their low cost. Samples 1 and 3, on the other hand, stand out as being of high cost for their apparent quality. The other samples appeared to be priced fairly well according to their respective qualities as determined by this test. This correlation is shown graphically in Fig. 5.

In an effort to correlate some of the data obtained in the oxidation test of these oils, with their changing characteristics in service, Brands 2, 3 and 12 were chosen for service tests. Brand 2 is a low-priced paraffin-base oil; Brand 3 is a relatively high-priced paraffin-base oil; and Brand 12 is a low-priced oil, refined from an asphaltic-base crude. These oils were chosen because they appeared to represent three distinct classes of oil from a cost standpoint.

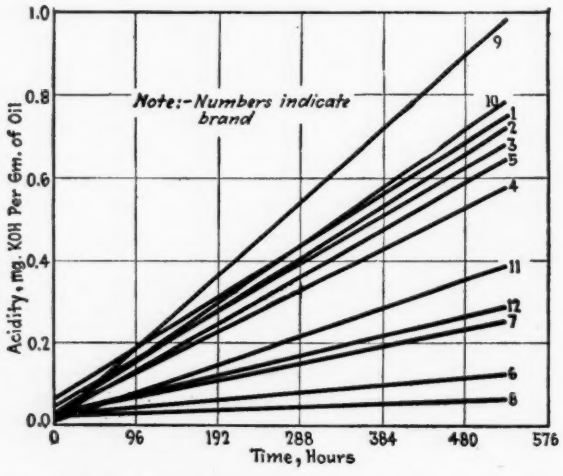

Fig. 3—Development of acidity average during oxidation test—all brands

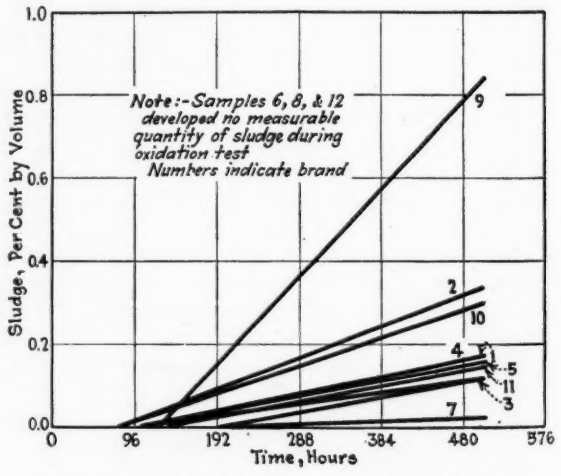

Fig. 4—Average development of sludge during oxidation test

TABLE I — PROPERTIES OF THE TURBINE OIL SAMPLES TESTED (NEW OR AS RECEIVED)

Brand	1	2	3	4	5	6	7	8	9	10	11	12
Specific gravity at 60 deg. F.	0.873	0.870	0.871	0.867	0.880	0.865	0.891	0.866	0.898	0.871	0.888	0.911
Specific gravity at 60 deg. F., deg. Be	30.2	30.9	31.0	31.5	29.0	31.8	27.2	31.7	26.0	30.7	27.7	23.6
Flash point, deg. F.	410	420	405	420	395	370	390	405	425	410	390	345
Fire point, deg. F.	465	480	460	480	435	415	415	470	480	465	430	380
Viscosity, saybolt, sec.: At 100 deg. F.	153	163	156	155	141	139	177	159	203	154	160	164
At 210 deg. F.	44	44	45	44	43	43	44	43	47	44	43	42
Pour point, deg. F.	20	30	10	30	40	25	20	25	25	25	35	—35
A.S.T.M. emulsion number	42	36	36	57	45	81	60	35	92	39	65	89
Total acidity, milligram KOH per gram of oil	0.01	0.02	0.02	0.03	0.01	0.02	0.02	0.02	0.01	0.01	0.02	0.02
Unsaturated hydrocarbons, per cent by volume	11	8	8	8	7	2	5	3	15	11	8	6

TABLE II — PROPERTIES OF VARIOUS BRANDS OF TURBINE OIL BEFORE AND AFTER THE DETROIT EDISON TEST OF 500 HOURS

Sample Number	1	2	3	4	5	6	7	8	9	10	11	12
Viscosity, saybolt universal, seconds at 100 deg. F.:												
Sample as received	153	163	156	155	141	139	177	159	203	154	160	164
After stability test	164	168	157	159	149	178	179	152	226	175	164	166
Difference	+11	+5	+1	+4	+8	+39	+2	—7	+23	+21	+4	+2
A.S.T.M. steam emulsion number:												
Sample as received	42	36	36	57	45	81	60	35	92	39	65	89
After stability test	603	260	405	425	200	96	332	227	1,200+	258	185	381
Difference (increase)	561	224	369	368	155	15	272	192	1,108+	219	120	292
Acidity, milligram KOH per gram oil:												
Sample as received	0.01	0.02	0.02	0.03	0.01	0.02	0.02	0.02	0.01	0.01	0.02	0.02
After stability test	0.71	0.67	0.69	0.53	0.61	0.10	0.23	0.08	0.94	0.73	0.39	0.27
Difference (increase)	0.70	0.65	0.67	0.50	0.60	0.08	0.21	0.06	0.93	0.72	0.37	0.25

Because of convenience in plant operation, these three brands of oil were tested each in one of the following types of units.

Brand No. 2 ..... G. E. horizontal, 20,000-kw. turbine generator. Oil capacity, 800 gal.

Brand No. 3 ..... G. E. horizontal, 50,000-kw. turbine generator. Oil capacity, 2,200 gal.

Brand No. 12 ..... G. E. horizontal, 20,000-kw. turbine generator. Oil capacity, 800 gal.

The reservoirs, sumps and piping incident to the lubricating systems of each of these units were drained and thoroughly cleaned before the oil to be tested was installed.

After these units were filled with the required amounts of their respective brand of oil the units were operated according to the general practice of the plants in which they were located. Each week a quart sample of oil was removed for laboratory tests. Records were kept of such operating data as hours of operation, water and sludge removed from the oil, temperature of the oil entering the bearings, and also temperature of the oil leaving the bearings, as well as the amount of make-up oil. The changes in acidity, steam emulsion number, and viscosity brought about in the oil during use in these units are given in Figs. 6, 7 and 8. These values are plotted against hours of operation.

Below are given the number of pounds of sludge developed in the oil for each 500 hr. of operation during the service test. The values of which these figures are averages vary over a wide range, but do not appear to have any definite trend.

Brand	
2	7.5 lb.
3	Trace
12	3.6 lb.

The conditions to which the oil was subjected during the operation of these units were not the same in all cases. The 20,000-kw. units in which Brands 2 and 12 were given service tests were approximately twenty years old, and the temperature of the bearings of these two units was between 120 and 140 F. Considerable steam found its way into the oil systems of both of these units. The rate of such leakage averaged 0.6 gal. per hour. This was removed by continuous operation of a De Laval centrifuge, bypassing a certain amount of oil for purification.

The 50,000-kw. unit in which Brand 3 was tested was new at the beginning of the service test. The bearing temperatures varied over a range of from 125 to 145 F. An amount of water equivalent to about 0.001 gal. per hour was extracted from the oil in this

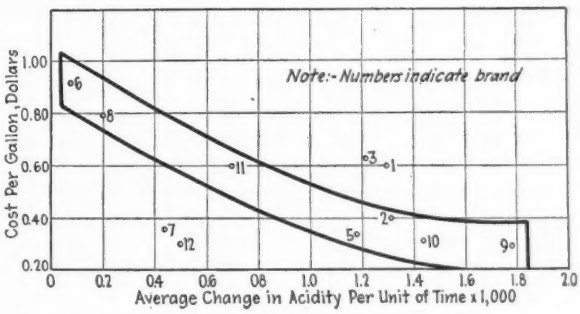

Fig. 5—Relation of rate of change of acidity to cost per gallon

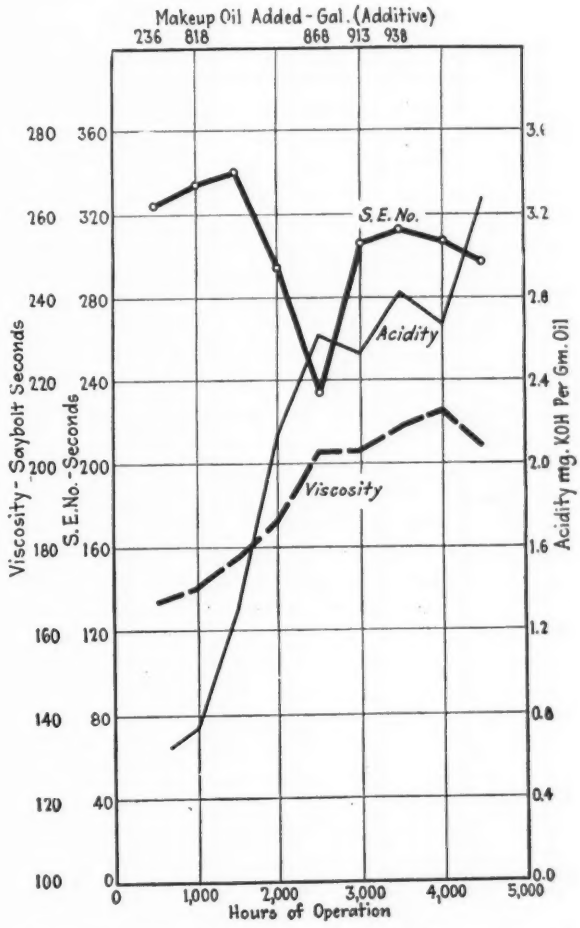

Fig. 6—Development of characteristics in service, Brand 2

unit by the aid of the centrifuge, which operated but 15 hr. each week.

The fact that the conditions obtained in these three units were not the same in all cases was recognized prior to these service tests, but no other units in which oil service tests could be run were available.

A study of the curves given in Fig. 3 and the general trend of the acidity curves given in Figs. 6 and 8 indicate that there is a definite relationship between the results obtained in our oxidation tests and the results obtained in service in the case of these two oils. This conclusion is verified if the following calculations are made.

From the acidity curves given in Figs. 3, 6 and 8 are obtained the values for rates of development of acidity, both in the oxidation test and in service. Average rates of development of acidity, as milligrams KOH per gram of oil per hour, are found to be:

	Accelerated Oxidation Test	Service Observations
Brand 2	0.0013	0.00051
Brand 12	0.0005	0.00018

These values may be related as follows:

$$\text{Brand 2} \quad \frac{0.0013}{0.00051} = 2.6$$

$$\text{Brand 12} \quad \frac{0.0005}{0.00018} = 2.7$$

For practical purposes, it is believed that these ratios may be considered as being equal. This indicates that there is, at least in similar units, a direct relation between the results obtained in the oxidation test and the results that may be obtained in service. These ratios also indicate that oxidation products developed about three times more rapidly in the accelerated oxidation test than they did under service conditions in the 20,000-kw. units.

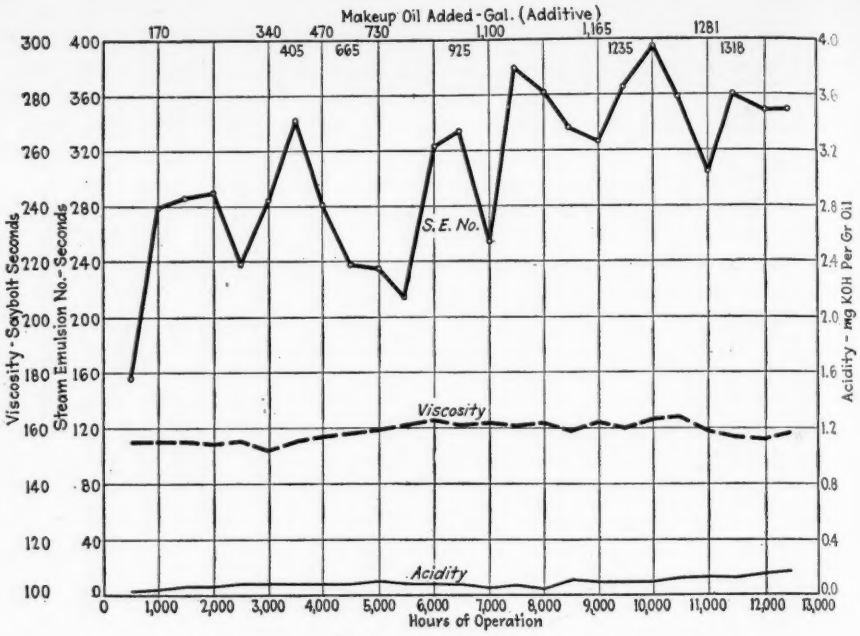

Fig. 7—Development of characteristics in service, Brand 3

The rates of development of acidity in the oxidation tests of Brands 2 and 3, as shown in Fig. 3, are believed, for all practical purposes, to be the same. This indicates that these oils are of the same quality and should, therefore, behave similarly in service. That they do not is borne out by a comparison of the results shown in Figs. 6 and 7. It is believed that this discrepancy arises from the fact that the operating characteristics of the two units in which these two brands of oil were used are quite different, and that oils of Brand 3 and Brand 2 might be expected to give equal satisfaction under similar service conditions.

The curves in Figs. 6 and 8 indicate that Brands 2 and 12 increased in viscosity to a marked degree during the service test. This increase in viscosity apparently did not appreciably affect the lubricating qualities of the oils, because the difference in the temperature of the oil entering and leaving the bearings remained approximately the same during the 3,500 hr. of operation in service.

The number of gallons of make-up oil added to turbine units is also of considerable interest. The unit in which Brand 2 was tested required 300 gal. of make-up oil during 3,500 operating hours, whereas only 150 gal. of make-up oil were added to the unit operating with Brand 12 during the same operating period. This may have been due to the difference in quality of the oils or it may have been due to the fact that the oils were refined from different type crudes and are composed, therefore, of materials of unlike chemical nature. Difference in rate of oil leakage during these tests may also have affected the rates of consumption, but previous observations on these two units have not indicated such differences in rate of oil leakage.

Although there appears to be a direct relation between the characteristics developed in oils in this oxidation test and those developed in the same oil during service in the 20,000-kw. units used in this study, it appears that, in the present state of their development, the results of laboratory oxidation tests cannot be used safely to predict the behavior of those oils in actual service in all turbines.

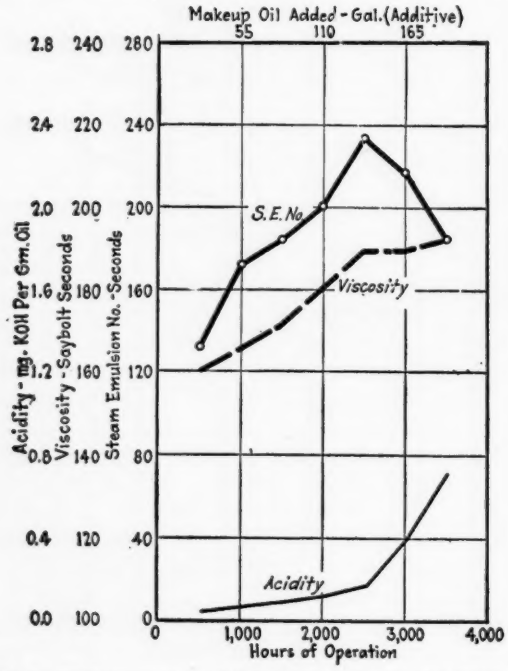

Fig. 8—Development of characteristics in service Brand 12

Cooperation Between Engineer And Boiler Inspector Insures Plant Safety

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Safety and reliability of the power plant depends upon the degree of cooperation existing between the engineer and the boiler inspector. Unless the two work hand in hand the plant may suffer from serious equipment defects which under more favorable circumstances would have been avoided

THE RELATION that should exist, and in many cases does exist, between the plant engineer and the boiler inspector is that existing between the family doctor and the specialist. In fact, the whole development of the boiler inspection idea closely approximates the development of the medical specialist field.

The general practitioner in medicine of days gone by ushered the latest addition to the family into the world; prescribed treatment for the childhood diseases; acted as the unofficial public-school physician and board of health; gathered with the kin-folks at the deathbed and signed the death certificate. So, in fact, from the swaddling garment to the shroud, he was the authority upon all matters even remotely influencing the health of the community.

However, human activities became more strenuous and complex. The disease which traveled slowly, due to low density of population in those early days, and which could be curbed with curative rather than preventive measures, became a plague to be eradicated only by a thorough scientific study and recognition of its underlying causes. As might be expected, the average doctor could do no more than obtain a general knowledge of the numerous special investigations reported in the technical papers available, while the specialist devoting his entire time and talent to the study of a single human organ or to the isolation of a single species of disease germ was in a position to diagnose and prescribe where the doctor had been mystified or deceived by the symptoms. As a result, we are now given a general examination by our family physician and taken by him to a consultation with a specialist regarding the trouble we are experiencing or anticipating.

The specialization which has taken place in the medical and surgical professions has been duplicated in power engineering. An engineer in a small establishment was accustomed, in the old days, to meet and solve his engineering problems in his own way and as a result developed considerable ingenuity. There was no one in his organization with whom he could confer, and to appeal to another engineer for advice was to acknowledge a degree of inferiority.

However, the power plants of the larger industries, as well as those of the public utilities, require engineering organizations in keeping with the importance of the operation, the development in equipment, and the financial investment involved.

As a consequence the individual engineer became a group and the group became a multitude of 500 or more power house employees, all for the purpose of furnishing uninterrupted service to the industry or the public. The engineering executive cannot have a personal knowledge of the condition of each tube, bolt or bearing in the plant, but depends upon his subordinates for information regarding the dependability of the piece of equipment operated by each.

The interdependence of the electrical generator upon the steam-actuated prime mover, the turbine upon the boiler and the boiler upon the auxiliaries requires frequent exchanges of ideas and information, from which has grown the system of engineering conferences where detail of all kinds is discussed with complete freedom.

The duty of determining definitely the repairs needed, how and when best made, the greatest length of outage without impairment of service, and the justification of the repair expense as compared with the cost of installing new equipment, has compelled the engineer to crystallize his opinions. These opinions must be based

on logic rather than sentiment, and his conclusions predicated on the success of the plant as a whole, although the object to which his operating attention is given may appear to be an insignificant link between the coal bunker and the switchboard.

The periodical examination of the steam generators, prime movers and auxiliaries is an important and necessary function of the operating organization. In some jurisdictions the interest of the public in the protection of the citizen has led to the enactment of legislation requiring the engineer in charge of a steam boiler to establish his ability to operate it with safety before he receives his operator's license. Many states and cities have laws requiring that boilers be given a periodical inspection by a commissioned inspector not employed by the owner, thereby using the specialist to assist the general practitioner.

This inspection by the state, city or insurance inspector is not intended to supersede, but rather to supplement and reinforce, the more frequent examinations made by the operating crew. So there is every reason to expect complete co-operation.

The owner or engineering executive who is to examine a piece of power plant machinery to determine its general condition or to discover a defect to which operating difficulties have been attributed expects the watch engineer to have it in complete readiness at the appointed time. The insurance inspector, the specialist, is a representative of the owner and should be provided with all assistance and facilities needed to make the inspection complete, without any obligation, expressed or implied, to those engaged in the preparation.

The permanence of the insurance inspector's employment gives him the opportunity to investigate all kinds of boiler ills, their causes, effects and remedies, and, as he passes from plant to plant, to absorb a wonderful store of knowledge and to develop the ability of interpreting symptoms which singly would be passed unnoticed. He has had power plant operating experience, or shop construction experience, frequently both, followed by intensive training and instruction in inspection work.

He may have encountered the necessity of specializing in the inspection of a certain class of equipment such as used in the paper-making industry, the food-packing plants, central power generating stations or in boiler shops.

Discovery of an unusual condition is followed by a discussion and, in many cases, by an extended investigation in which older heads participate. This is beneficial to the engineer as well as to the inspector, even when the condition may be due to poor judgment on the part of the former, or to misunderstanding the seriousness of the evidence of disintegration observed at previous inspection visits.

An inspector assigned to boiler, turbine or engine shop work is not in the direct employ of the manufacturer, nor of the purchaser, so he is impartial and represents both in the effort to build and install safe equipment which can be depended upon to operate with a minimum of outage for repairs possible to be made without unusual difficulty or excessive expense.

In doing this shop inspection work skillfully and conscientiously he is contributing to the safety of the operating crew, frequently entire strangers to him.

The operating efficiency of the apparatus is of no professional interest to an inspector, but, due to his knowledge of the economies being effected elsewhere, he has been able to convince the owner of old, obsolete, inefficient boilers and engines that savings would follow the installation of a modern power plant, even where the old could have been continued in service with a reasonable degree of safety.

An engineer justly may be proud of the boiler room and engine room under his control. He may or may not know that the new plant grew out of a discussion between the inspector and owner. The owner probably did not realize the suggestions given him regarding the advantages of improved furnaces, higher pressures, superheated steam and feed-water treatment were gathered here and there by the inspector upon his travels as he read, saw and heard what was going on.

"An inspector assigned to boiler, turbine or engine shop work is not in the direct employ of the manufacturer nor of the purchaser, so he is impartial and represents both in the effort to build and install safe equipment which can be depended upon to operate with a minimum of outage for repairs possible to be made without unusual difficulty or excessive expense."

If the engineer had individualistic tendencies, the old-time inspector, too, was human and his keen interest in the safety of the boilers under his supervision led him at times to take action which was little short of despotic. To enforce his mandate that a boiler in which he had detected the earmarks of a lap seam crack must not be placed in service until he had conferred with his chief, an inspector took one of the handhole plates with him to the long-distance telephone booth, so the boiler could not be filled with water. The crack in the sheet was sufficient to cause the permanent retirement of the boiler from service and justified the temporary theft of the handhole plate.

More recently, the engineer of a power plant at a state institution where a large number of people were confined objected to the removal of rivets from a double butt-strapped seam that an inspector believed was defective because new rivets and a copper calking strip had been insufficient to maintain tightness, and the feed-water treatment was not being supervised as carefully as he thought it should be. "Alarmist" was the name applied to that inspector even after he had explained that he had no reason to fear for his personal safety, as he would be many miles away when an explosion occurred if the plate were defective, but he considered the operators and executives as well as the inmates to be in danger. The rivets, and, in fact, the butt-straps, were removed eventually. A caustic embrittlement crack 42 in. long was found. Other seams of that boiler and of other boilers in the plant were seriously affected from the same cause.

The engineer operating a boiler plant under conditions which have resulted in caustic embrittlement of the steel at the seams where the caustic has concentrated may be certain that all is well and fail to endorse, if he does not actively oppose, the inspector's efforts to determine the extent to which defects may have developed. However, after the rivet is removed, the wall of the rivet hole thoroughly cleaned, the miscroscopic cracks located and pointed out to the engineer, he invariably appreciates the technique of real inspection work. It may be that

the inspector's suspicion was aroused by the appearance of the scale, by the lather resulting from the use of standard toilet soap in a bucket of boiler water, or by a missing rivet head or a seam leakage. The inspector's effort, frequently extended over a period of six or eight years, while the defects are developing, requires a confidence based upon experience, an enthusiasm which knows not failure, and work involving 95 per cent perspiration and 5 per cent ingenuity.

The cooperation each inspector receives from the engineer and from the owner in his endeavor to determine the condition of those hidden parts is most encouraging. In a few cases where cooperation has been lacking or opposition encountered, the condition discovered when the part has been exposed confirms the good judgment of the inspector in insisting upon preparation for a close inspection.

The sound material of one head which was uncovered for examination after considerable discussion was found to have been reduced to $\frac{1}{16}$ in. in thickness as a result of external corrosion and a flange knuckle crack. Of approximately 4,000 buried heads exposed for examination, 400 were found to be corroded to a considerable extent, and replacement of all would have become necessary if the condition had continued undiscovered. The preparation necessary to permit a thorough examination of each buried head no doubt did require some expenditure of time, effort and money, but each defective head discovered represented an explosion prevented and the life of an engineer saved.

The purpose of an inspector's visit is clearly understood. He is to make a careful examination of the boiler, engine, turbine, motor or elevator and report the condition in which he finds it. A copy of this report is sent to the owner. An object that can be given a clean bill of health is the inspector's delight, but if improvements are needed he has no choice but to embody the proper recommendation in his report. An engineer acting upon the suggestion of an inspector when making some boiler repairs saved $6,000 as compared to the cost of similar repairs made previous to the discussion of the subject. That inspector's advice was worth acting upon.

There are, of course, isolated cases where an inspector has complained of an engineer and of his indifference to the safety of the plant. Likewise, an engineer may conclude that all inspectors are necessary evils just because he has had a disagreeable experience with one.

As each has duties which he should understand thoroughly, there is no reason on the part of either to cultivate a "holier-than-thou" feeling, even if some inspector occasionally does rush into print to declare that other inspectors are without ability, experience and judgment, and are undeserving of the certificates of competency required by many states and cities. Such statements can leave no other than an unfavorable reaction, and the thought that the complaining witness in the case may have ulterior motives and may himself be lacking in those qualities necessary for real inspection work.

The cooperation of engineer and inspector, however, has brought credit to both so many times that any lack of team work appears to be the exception rather than the rule.

This cooperation must continue, as it is essential to the successful operation of the plant and is to the advantage of both engineer and inspector, who have the joint responsibility of protecting the public, the employees, the continuity of the service and the capital investment.

Preparing Cuprous Chloride Solution for Gas Analysis

By R. E. SUMMERS

Assistant Professor of Mechanical Engineering
Oregon State College

IN THE anaiysis of gases by chemical absorption, as with the Orsat apparatus, a solution of cuprous chloride is commonly used for the determination of carbon monoxide. Considerable difficulty is often experienced in obtaining the solution because of the tendency of cuprous chloride to pass into cupric chloride.

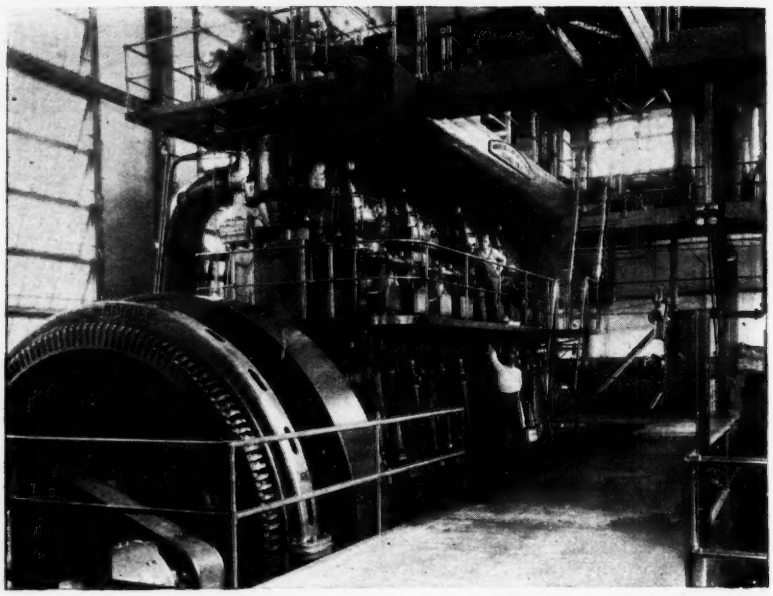
A satisfactory product is almost never obtained by dissolving the commercial salt of cuprous chloride, so that the solution is usually made by some indirect process such as that of the action of hydrochloric acid on copper oxide in the presence of copper. These methods have the disadvantages that they are none too positive and they require time, perhaps weeks, for completion.

A direct and rapid procedure for the preparation of cuprous chloride solution is used by the writer and may be of some general interest. Quantities of crystalline copper sulphate, $CuSO_4 \cdot 5H_2O$, and ordinary salt, NaCl, are weighed and mixed in the proportions of approximately 249.69 grams (one mol) of the former to 87.69 grams (one and one-half mols) of the latter and the salts are stirred into water just sufficient to dissolve them. About a quart of water is enough.

Into the resulting solution there is bubbled a generous stream of sulphur dioxide gas such as can be obtained in small cylinders from any repair shop for household electric refrigerators. As the gas is passed into the solution, white crystals of cuprous chloride are deposited and settle to the bottom of the container. When sufficient gas has been used to complete the precipitation the crystals of cuprous chloride are recovered by decanting from them the bulk of the spent liquor and then filtering the residue. The crystals are washed first with water saturated with sulphur dioxide and then with hot water. The washing operation must be carried out with dispatch and with a minimum exposure of the crystals to oxygen of the air. A brown color indicates change to the cupric state. The washed crystals should be immediately dissolved in 500 c.c. of hydrochloric acid made up of concentrated acid diluted 1 to 1 with water. The resulting solution, which is suitable for CO absorption, is kept in a tightly stoppered, dark-colored bottle in contact with a quantity of metallic copper. It may be noted that the quantities called for herewith make about 500 c.c. of solution for use in an Orsat.

If desired, the ammoniacal solution of cuprous chloride is made by rendering the acid solution alkaline with NH_4OH. Whenever the acid solution is used in an Orsat apparatus it should be remembered that the HCl in the reagent has a high vapor pressure and gas samples placed in contact with the solution should be exposed to an alkali before their volumes are measured for the determination of CO absorption. In the conventional apparatus, potassium hydroxide is the reagent most used to take out carbon dioxide. When a gas sample is withdrawn from the acid cuprous chloride solution, it should, therefore, be re-exposed to the carbon dioxide solution before it is drawn into the measuring burette for reading the difference in water level and calculating the loss of carbon monoxide.

By LOUIS R. FORD
Consulting Engineer, New York City

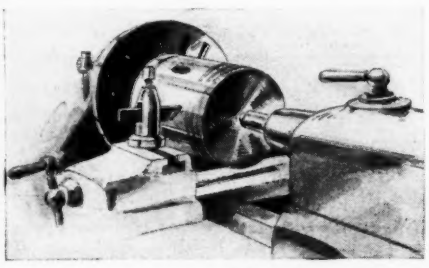


Repair Equipment for the Diesel Power Plant

Many diesel plants are almost devoid of machine tools and all repair work is done in outside machine shops — a costly procedure. In this article Louis R. Ford, from his extensive experience with diesel engines, gives a list of the essential tools and outlines how far the engineer should go in doing his own repairs

IN ANY TYPE of power plant every effort should be made to accomplish all maintenance and repair work with the materials, equipment and labor available within the plant because, as a general rule, the cost of outside purchased service is apt to be high. In the diesel power plant, where there are no boilers, steam pipes, condensers, coal- and ash-handling equipment, it would seem at first thought that the selection of proper equipment to enable the operating force to take care of all such work should be a simple matter. There are, however, a number of factors to be considered which may act to modify this conclusion. Among these are: Size of plant, nature of the service in which it is used, nature of the repair facilities available in the immediate neighborhood and type of labor available. Giving due weight to these factors one may arrive at some general conclusions as to how nearly self-sustaining the diesel plant can be made and form some idea as to the nature and amount of equipment required.

Size of plant is a factor of great importance because of its influence on other elements that enter into consideration. In the first place the necessity for special equipment for repair and maintenance work is much more apt to be apparent to the management or owner of a plant containing several engines of large size than it is in the case of a single-engine plant of small power. Also, the size of the plant has considerable influence in fixing the wage scale and determining the quality of attendance considered necessary.



An indication of the influence of nature of service on maintenance policy may be had by considering the difference between the type represented by a power plant supplying year-round lighting and power service to a municipality and that represented by an irrigating plant or rice-milling plant, the operation of which is seasonal. In the first case continuity of operation is of prime importance, routine work must be carefully scheduled and facilities for quick handling of breakdown repairs must be available. In the second all routine work can be taken care of during the non-operating period and even breakdowns during the operating period are not so serious, consequently the facilities for quick repairs are not so important.

Nature of repair facilities available in the immediate neighborhood has the effect of neutralizing in some ways the influence of size of plant. A large plant located in or near an industrial center where well-equipped machine shops are at hand, may require much less repair

equipment than a much smaller plant located in a rural community where the total available facilities for metal working may be found in the local blacksmith shop. The type of labor available will obviously affect the utility of any repair facilities that might be included in the plant equipment. A well-equipped machine shop will not justify its existence if the operating personnel does not have the experience and skill required to use it.

It may be seen, then, that no universally applicable rules can be laid down in regard to the specific items of equipment that should comprise the repair facilities of a diesel plant. It is possible, however, to analyze the diesel engine from the operating standpoint and determine the nature of the repair work likely to be required, after which one can form a fairly accurate idea as to the tools and equipment required to perform this repair work.

Up to this point the analysis is of general application, but beyond this each individual plant must be considered on the basis of the factors previously outlined, and on the basis of any other factors peculiar to the plant in question. These factors will then determine how much of the equipment, the nature of which has been established by the general analysis, should be incorporated in the particular plant under consideration.

The repair work that must be considered may be divided into two classes. The normal maintenance work made necessary by wear of working parts, and the replacement of parts broken in service.

The engine parts that may be expected to require attention because of wear will include the cylinder head, valves and valve gear, pistons and piston rings, bearing boxes, air compressor valves and pistons, fuel pumps and pump operating gear, water circulating pumps and lubricating oil pumps. Another item that should be included with these, although it is not, strictly speaking, attributable to wear, is the repair of leaky joints in the various piping systems. Specific parts of driven machinery subject to wear cannot be itemized in a general analysis because of the wide variation in the types of such machinery found in different plants.

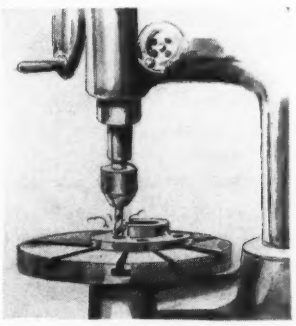
The work most often called for in connection with valves is regrinding or recutting of valve disks and seats. As simply a hand operation this requires little more in the way of equipment than the wrenches ordinarily supplied with the engine, but it will be found that a standard engine lathe will be of great value in many ways in connection with this work. Sooner or later the valves or their cages will require their seats to be machined. There are on the market now reseating machines with which this work can be done very expeditiously, but such a machine is not necessary if a lathe is available. A small tool-post grinder, in connection with the lathe, can perform reseating operations on practically any type of valve or cage. Its usefulness is not restricted to this sort of work, however, as there are many other jobs for which it can be used. Checking the valve stems for straightness and straightening them if bent may be done in the lathe in connection with the reseating operation.

Wear of valve gear is usually confined to pins, bushings and rollers. With the lathe and tool-post grinder worn pins may be reground and new bushings made to fit them. The making of new valve rollers usually involves the use of a heat-treating outfit for case hardening, a type of equipment not justified in the average power plant, but fairly good results can be obtained by cyanide hardening in the ordinary blacksmith's forge. If this cannot be done it is possible to obtain very hard but more expensive rollers by turning them in the lathe from tool steel then hardening them by heating and plunging.

The only sort of piston wear that ordinarily occurs is in the ring slots. If this sort of wear proceeds very far the fitting of new rings is of little value and it becomes necessary to true up the ring slots in the lathe. The slots that are worn can be machined out until true and new rings of greater width installed. If many of the slots are worn, however, it may be better to machine out all of the slots to a standard width and install a complete set of new rings. This will make it unnecessary to carry in stock several different sizes of spare rings. If wear of the slots is so great that truing up of the sides will make the lands between slots too narrow the only recourse, if the piston is to be salvaged, is to build up the sides by welding in new metal, for which a welding outfit is required. Whenever possible new rings that are purchased should be obtained from manufacturers who specialize in the production of such rings. Even the engine manufacturers themselves cannot produce rings as good as those made by specialists in that line and it is the almost universal custom for engine manufacturers to buy their rings. In the plant, however, occasions may arise when rings are needed in a hurry and if a lathe is available fairly good ones can be made in a fraction of the time required to get them from a manufacturer.

Ordinary wear of the various bearing boxes on an engine calls for no more fitting than can be done with hand tools, but if the wear is excessive, or if the babbitt cracks or burns, relining is required, followed by boring. In a large machine shop such boring is usually done in a horizontal boring machine or a vertical boring mill, but where only a lathe is available the boxes can be held in the chuck, if small, or mounted on the carriage, if large, and bored very nicely.

Air compressor valves and cages that are too badly worn for hand grinding can be machined in the lathe.



The air compressor pistons are subject to the same sort of wear as the power pistons and the remarks concerning the latter apply equally to the former. In connection with many of the repair operations involved in the items mentioned, the necessity for drilling holes of various sizes frequently arises. Many such holes can be drilled in the lathe if necessary, but the much wider range of usefulness of the drill press makes the standard upright drill an almost indispensable accessory.

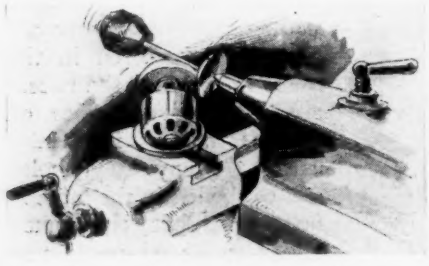
Fuel pumps and their operating gear may require such operations as grinding of plungers, boring of barrels, turning up of pins, boring bushings and making new valves, all of which call for a lathe. Some operations, such as machining ports in pump barrels, finishing forks of plungers, etc., can best be performed with a milling machine.

For pipe repairs the ordinary hand dies and taps are useful when working with pipes of small size, but 2-in. pipe is about the largest size that can be worked by hand, unless the more expensive gear and ratchet operated dies are available. With the lathe, however, the range of pipe work can be greatly extended. The very large sizes of pipe can be cut and threaded in a rather small lathe, also flanges can be faced and threaded. Even when

working with small pipe a close nipple is difficult to thread with a hand die but the smallest and shortest nipples can be cut and threaded in the lathe. In pipe work, as in nearly every other kind of metal work, it will be found that drilled holes are often needed. It is impossible to specify all the jobs for which a drill press will be needed, but the drilled hole is such a fundamental feature of all metal machinery that the drill press is indispensable.

Summing up, either of two general conditions may exist; one in which only hand tools are to be supplied, the other in which machine tools and hand tools are included in the maintenance equipment. In the first case the equipment should include, in addition to such special tools and wrenches as may be supplied with the engine, the following: monkey wrenches, pipe wrenches and open-end wrenches; hammers, chisels, files and scrapers; hack saw and blades; breast drill and drills up to $\frac{1}{2}$-in.; machine taps and dies, from small screw size up to 1 in., pipe taps and dies from $\frac{1}{4}$ to $1\frac{1}{4}$ in., hand operated bench grinder, screw drivers and pliers, tinner's shears, wood bit with augurs to about $1\frac{1}{4}$ in.; wood saw, plane chisels, inside and outside calipers, combined level, protractor and scale, blacksmith forge of small, portable type, anvil, blow torch, soldering iron and bench vise. This list, though fairly complete, does not exhaust the possibilities in the way of hand tools and may be added to or modified to suit individual ideas.

Considering the second case, where machine tools are to be supplied, it is evident from the preceding brief summary of repair requirements that the lathe, of all machine tools, has the widest range of usefulness and it may be seen that for any plant the maintenance possibilities are very greatly enlarged if the equipment includes even one lathe. If a single machine tool is to be the limit of the investment the lathe is the most logical selection. Next in importance to the lathe is the drill press, or standard upright drill. With these two tools, supplemented by the ordinary hand tools found wherever machinery is used, the engineer possessing average skill and ingenuity is to a large extent independent of outside help in maintenance work. These two simple machines do not represent a large investment and they should be considered as about the minimum equipment that should be installed. Next in the scale of importance one may list the shaper, and as the machine-tool requirements become progressively more elaborate a milling machine may be added. Any of this machine equipment will require a grinder, of either the column or bench type, for tool sharpening and general grinding.



The cost of any of these tools will, of course, vary with their size, consequently the smallest sizes that will do the work should be used. In the case of the lathe one may use the diameter of the engine pistons as the limiting factor.

In conclusion it may be said that in any diesel plant of 1,000-hp. or more, adequate machine tool equipment will soon pay for itself in repair expenses saved. For a plant below this size the initial investment may represent too large a cost to be economically justified.

Many New Standards Established in 1931

FOREMOST in standardization activities of 1931 was completion and final adoption of rules for welded boilers by the A.S.M.E. Boiler Code Committee. These rules, which were evolved as a result of ten years' study and discussion, cover all power boiler drums, small boilers and three classes of unfired pressure vessels, fabricated by fusion welding. They require the highest type of welding and specify X-ray examination of all joints.

During the year the Test Code for Liquid Fuels and the Test Code for Atmospheric Water-Cooling Equipment were completed by the A.S.M.E. Power Test Codes Committee. In addition several sections of the Instruments and Apparatus Code were finished, together with revisions of the codes on centrifugal and turbine-compressors and blowers, steam-electric power stations, steam turbines and graphical symbols. Through membership on the United States National Committee of the International Electrotechnical Commission, the Power Test Codes committee assisted in furthering international agreements on acceptance tests for steam turbines and internal-combustion engines.

Twenty-seven new national standards affecting almost every important industry in the United States were completed in 1931 by technical committees working under the auspices of the American Standards Association. These included: Symbols for Heat and Thermodynamics; Specifications for Cast-Iron Pipe Flanges and Flanged Fittings for Maximum Working Saturated-Steam Pressure of 25 Lb.; Safety Code for Elevators, Dumbwaiters, Escalators; and National Electrical Code.

Among the new projects initiated by the A.S.A. were those covering leather belting; preparation of clean bituminous coal; constant-current transformers of the moving-coil type; transformers, induction regulators and reactors; capacitors; and 60-cycle test voltage for standard transformer bushings. Two new committees were organized by the association; namely, the Electrical Standards Committee and the Sectional Committee on Electric Welding Apparatus. The former supersedes the Electrical Advisory Committee of the A.S.A. It will centralize the standardization work of the electrical industry and act in the capacity of the United States National Committee of the I.E.C.

The Bureau of Standards reported that 10,000 different associations and firms are now listed by its division of simplified practice as acceptors of simplified practice recommendations. There are over 120 recommendations in effect, with an estimated saving to industry of more than $250,000,000. During the year the division carried forward its work of standardizing the capacity ratings for low-pressure steel heating boilers and initiated a revision of the recommendation on carbon brushes.

Other standardization activities worth noting included the adoption of the "L Code," a simplified telegraphic code sponsored by five electrical societies for the utility and electrical industries; the organization of a committee by the National Association of Purchasing Agents to develop uniform markings for valves and fittings and promote their general adoption by manufacturers; and the completion of rules for the fabrication of hangers, supports and vibration dampeners for pressure piping by the A.S.M.E. Committee on the Code for Pressure Piping.

Preventing Temperature Effects On Chlorine Gas

IN a municipal pumping station a chlorine system was installed to purify the water. The tanks of chlorine gas were received charged at 75 lb. pressure. In the summer months the temperature in the pump house was so high as to cause the pressure in these tanks to build up as high as 150 lb. Several of the pumps were driven by water power, the dam giving a 25-ft. head of water above the floor elevation in the pump house.

The most practical method of preventing this excessive pressure in hot weather was decided to be as follows: Three-quarter inch copper tubing was wrapped in a coil for the entire height of the chlorine tank. The lower end of this coil was connected into the tailrace of the waterwheel. As there would be certain times when no pumps would be running, the top of the coil was connected through a $\frac{3}{4}$-in. gage valve to a suitable strainer just below the low-water level of the dam. By adjustment of the gate valve the temperature and pressure of the chlorine gas was easily controlled without further difficulty. The coil was wrapped loose enough to permit removal of the tanks for replacement.

▼

Largest Pumped-Storage Hydro Project in Germany

By NIKOLAY VON ROTSCHUBEY

Engineer
Zurich, Switzerland

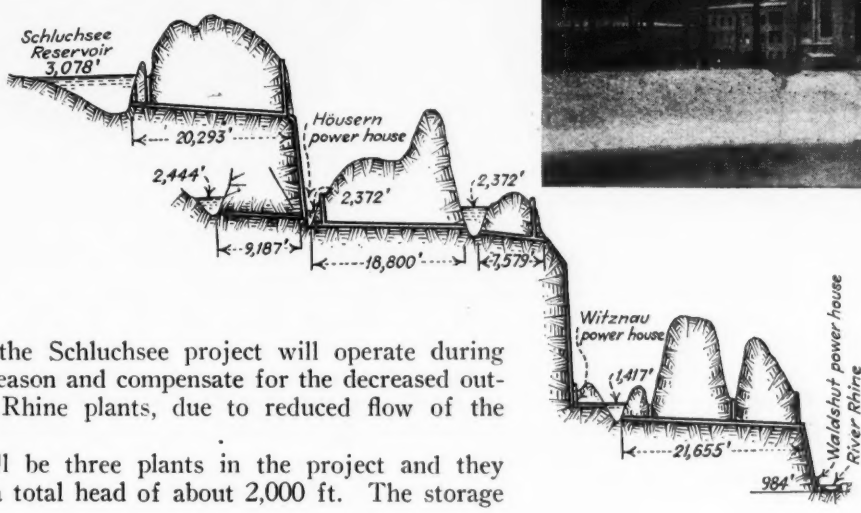
THE FIRST power house of the largest pumped-storage hydro-electric project in Germany was recently put in regular operation at Schluchsee. This water-power development will form an important part of the power system in the province of Baden, operated by the Rheinisch Westfälische Elektrizitätswerke, as well as for those of the Rheinfelden and Laufenburg companies. The latter two have hydro-electric power plants on the Rhine. The new power stations of the Schluchsee project will operate during the winter season and compensate for the decreased output of the Rhine plants, due to reduced flow of the river.

There will be three plants in the project and they will utilize a total head of about 2,000 ft. The storage reservoirs will be formed by the Schluchsee lake, having a capacity of 24-billion gallons, corresponding to about 135-million kilowatt-hours. The three plants will have an annual output of 520-million kilowatt-hours. Part of this energy will be obtained by storing water at night and by pumps directly coupled to the hydro-electric units.

The plant now in operation is located at Höusern, where an average effective head of 620 ft. is obtained. Five units have been installed, each consisting of a 23,000-hp. francis turbine directly coupled to a 30,000-kva. three-phase generator. Four of the units are connected to 80,000-g.p.m. pumps by a hydraulic coupling that disconnects the pumps during normal operation of the plant. Separate penstocks are provided for the turbines and the pumps.

A second power house at Witznau will use a head of 935 ft. It is expected that 153-million kilowatt-hours can be produced in this plant. The lowest plant of the project will be installed at Waldshut, and will discharge into the Rhine. An effective head of 350 ft. will be utilized here. The annual output of this plant will be about 84-million kilowatt-hours. The Electric Power Supply Company of the province of Baden purchases the power at 110 kv. while the Rheinisch Westfälische Elektrizitätswerke is connected to the Schluchsee system through a 220-kv. line. It was expected that the construction of the two remaining plants of the Schluchseewerke would be finished within two or three years. Present business conditions and the large decrease in electric power in Germany will probably postpone completing this work for some time.

The Schluchee power house has five 23,000 hp. units installed to operate under an average effective head of 620 feet



Left—Elevation of Schluchee pumped-storage hydro-electric development, which includes three power houses and a total head of about 2,000 feet

Of These Two WHICH

Microphotographs showing smoke particles and the solid particles emitted in pulverized coal burning, both to the same scale

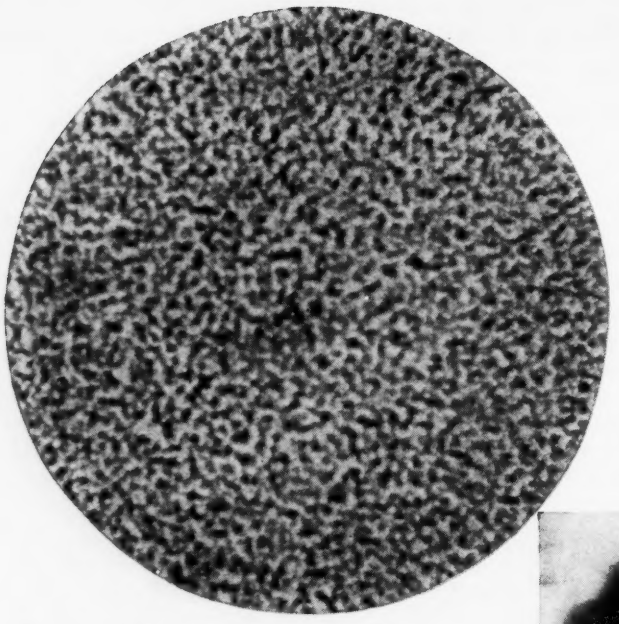


Fig. 1—Carbon black (smoke) condensed from volatile matter of bituminous coal. Magnified 1,250 diameters. The actual area photographed is smaller than the period in the type here used.

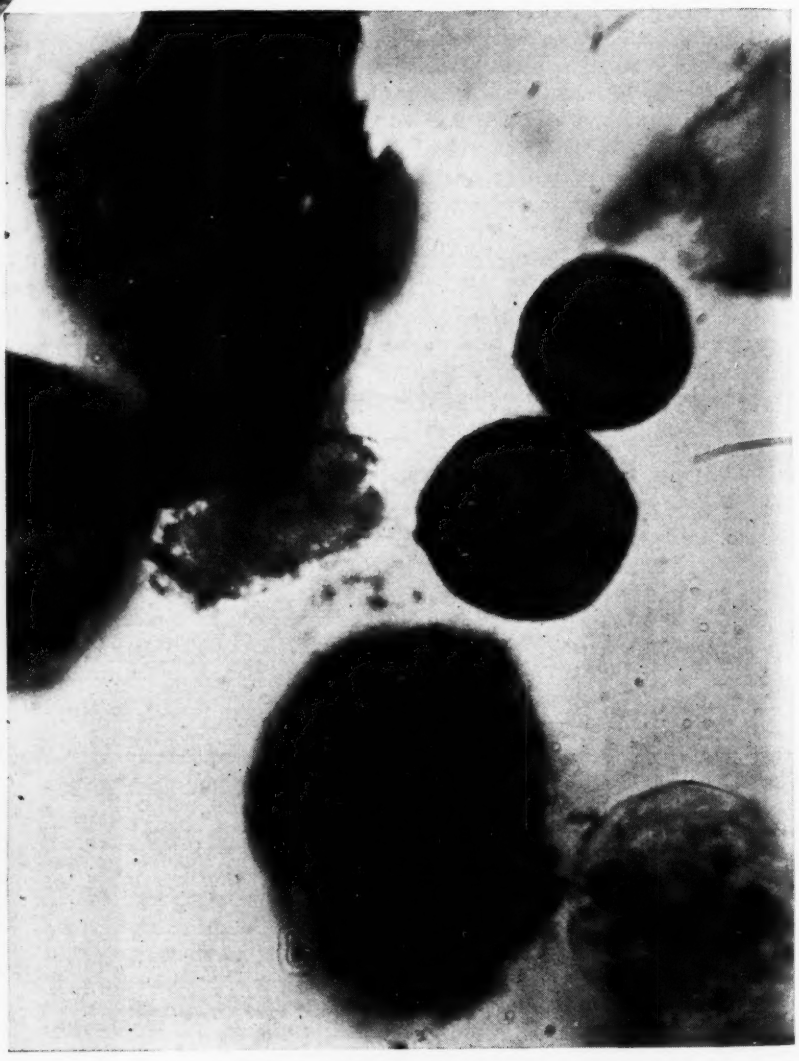


Fig. 2—Cenospheres in flue dust (from pulverized coal unit) which passed through a 325-mesh screen, photographed at the same magnification as Fig. 1

The term "smoke" is often applied indiscriminately to all visible solids arising from stacks. Here are two photographs of "smoke," both to the same magnification. They are totally different in grain size, appearance and nature. The upper photo shows true smoke, the lower stack dust. Prevention is a separate problem with each

THE GASES we see issuing from a smoke stack are made visible by the finely divided solid or liquid particles suspended in them. We are indebted to Prof. W. E. Gibbs[1] for a concise classification of these turbid gases.

When the particles are coarse and, on account of their size, fall freely under gravity, the condition is called a "dust." If the particles are small enough to fall slowly at a constant velocity, it is known as a "cloud." When, however, the particles are so extremely small that they show no signs of settling, but are driven about by the bombardment of the gas molecules, a condition exists called a "smoke." While we have been accustomed to call stack emission by the one name—smoke—it is of considerable interest to examine this efflux in the light of Prof. Gibbs' designations.

Since coal is used in greater quantities than any other fuel, it is correct to say that the majority of smoking stacks are discharging into the atmosphere solid particles originating from this fuel. Coal is made up of solid and gaseous matter[2] so that the combustion of this fuel consists in burning first the gaseous hydrocarbons

[1]Prof. W. E. Gibbs—"Some Factors Affecting the Problem of Smoke Prevention."—*The Institute of Fuel*, June, 1930.

[2]Douglas Henderson—"Diffusion as a Factor in Burning Pulverized Coal."—*Power*, Feb. 17, 1931.

IS SMOKE?

By DOUGLAS HENDERSON
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New York

or volatile matter and then the solid carbon residue. Incomplete combustion in either case will result in "smoke" as we have grown accustomed to term it, but not according to the definitions above.

Let us consider the combustion of the gaseous matter in the coal. It has long been realized that volatile matter has a direct relation to the smokiness of coal. Many coal consumers in eastern cities show a distinct preference for low volatile coals because of the less likelihood of producing smoke. This is particularly true in the case of hand-fired or stokered plants. When the volatile matter in the coal is not properly and intimately mixed with oxygen, the hydrocarbon molecule is "cracked" into carbon and hydrogen, the latter burning to water while the former passes through the boiler and up the stack. This form of solid carbon is so finely divided that it becomes classified definitely as a "smoke."

This is "carbon black" and curiously enough it is practically non-combustible, except under favorable circumstances such as high temperature and an atmosphere rich in oxygen. Most of us are acquainted with this form of carbon from its collection in the cylinders and on the valves of our automobiles.

Smoke Magnified 1,250 Diameters

Fig. 1 is a microphotograph of this form of carbon produced from incomplete combustion of volatile matter. Under the magnification of 1,250 diameters the dark specks of carbon are extremely small, but nevertheless arranged with regularity. This smoke, once formed, cannot be reconsumed, a fact recognized by Professor Breckenridge[3] almost a quarter of a century ago when he said "the problem of smoke prevention is the problem of perfect combustion. There is no such thing as smoke consumption and this term should never be used. There is such a thing as perfect combustion and this means smokeless combustion."

How Hydrocarbons Burn

Originally there were two theories regarding the combustion of gaseous hydrocarbons. The first one held that there was a preferential combustion of the hydrogen, while the second insisted that there was a preferential combustion of the carbon. As is usually the case when the theories disagree so completely as this, it only required further investigation to show that both were incorrect.

The modern theory, established by the researches of Bone and others, points out that the combination of the hydrocarbon molecule with oxygen forms first of all an alcohol which is converted into an aldehyde upon the reaction with more oxygen. The latter compound either breaks down into combustible gases, CO and H, or it may burn completely to CO_2 and H_2O. This process is termed "hydroxylation" because the first addition of oxygen to the hydrocarbon molecule gives the hydroxyl grouping (—OH) characteristic of alcohols.

If the conditions in the furnace favor hydroxylation, that is, the proper temperature of hydrocarbons and air, and if sufficient time is allowed for the intimate mixture of oxygen and hydrocarbon molecules, there will be no smoke. The process of hydroxylation is quite rapid under the necessary favorable conditions. As a matter of fact it has been found that in mixtures of methane and hydrogen, or methane and CO, the hydrocarbon burns faster than either the hydrogen or the CO.

It is to avoid "cracking" of the hydrocarbon molecule that preheated air, large furnace volumes and high furnace temperatures have been developed in modern combustion practice. In cases where these factors have been given consideration the combustion proceeds without smoke.

In older plants where any one or more of these factors has been neglected smoke has always been a disturbing problem, solutions of which have followed along the course of expediency by using low volatile coals, or by modifying the furnace in an attempt to improve the mixing of the volatile gases with air. It has been this variety of smoke with which our smoke abatement committees have for many years been working to curb.

Action of Solid Carbon

When we consider next the solid carbon in the steel originally we find that it, too, has caused stack emissions that have been erroneously called smoke. When the coal is fed to the furnace by hand or by means of mechanical stokers, it is definitely supported on some form of grate during the process of combustion. The volatile hydrocarbons are driven off, leaving the solid carbon residue to be burned on the grate. Under these conditions, if the carbon is not burned it finds its way into the ash pit where it is removed with the ash in the coal. It is only under rare conditions, in the typical industrial plant at least, that particles of solid carbon or ash are lifted from the grates and discharged from the stack.

With that system of combustion in which small particles of coal are precipitated into a hot furnace, we find conditions favorable to the entrainment of solid particles of ash and carbon from the furnace and out of the stack. In a previous article[4] microphotographs were shown of dust collected from pulverized-coal furnaces. Both the ash and the solid carbon are in the shape of hollow spheres and their buoyancy favors removal from the furnace by the draft. The design of furnaces to burn coal in this manner is so conducive to the complete combustion of the gaseous content of the coal that no smoke is formed, but the stack emission in these cases is a combination of ash and carbon with the former in the greater proportion. Due to the larger particle size the classification, according to Prof. Gibbs, is either a "dust" or "cloud."

Fig. 2 shows a microphotograph of dust particles screened through a 325-mesh sieve and magnified to 1,250 diameters, thus bringing it to the same scale as Fig. 1. The comparison between the two microphoto-

[3] Prof. L. P. Breckenridge—University of Illinois Bulletin No. 15, 1907.

[4] Douglas Henderson—"How Pulverized Coal Burns as Shown by the Microscope."—*Power*, July 28, 1931.

graphs is striking, and it serves more than anything else to establish the fact that combating smoke is a distinctly different problem from the elimination of dust. It should be again remembered that generally both these stack discharges are referred to as smoke.

Fig. 2 brings out in sharp definition two carbon cenospheres with other particles of larger size, the largest of which passed through a screen with over 100,000 openings to the square inch. The transparent jelly-like mass in the lower right-hand corner is an ash cenosphere.

Centrifugal and electrical precipitation have been used to remove these particles, but when it is considered that 70 per cent to 80 per cent of them will pass through a 325-mesh screen, the difficulties involved become impressive. There is every reason to believe, however, that future developments in design will take care of both carbon and ash in such a way that their discharge from the stack will be eliminated.

As far as fuel loss is concerned, the carbon particles in the dust constitute a much greater waste than the molecular carbon in the smoke. The reason for this lies in the fact that our bituminous coals having a gas content between 15 per cent and 40 per cent with solid carbon ranging from 50 per cent to 80 per cent, present more opportunity for a solid carbon loss than for a smoke loss resulting from improper combustion. Actually but a small portion of the gaseous hydrocarbons need suffer "cracking" to create a dense smoke.

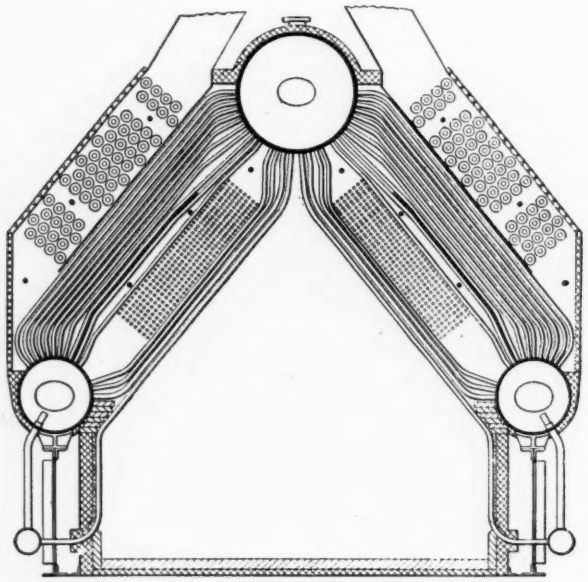
Whether the stack emission be "dust," "cloud," or "smoke," it constitutes decidedly more of a social nuisance and a health menace than a fuel waste. Realizing this, our health officers have become militantly interested in smoke abatement. There is no final solution to this problem to be had by enacting smoke ordinances that condemn smoke, dust, cinders, etc. The cause must be sought at the source to which very constructive remedies may be applied. Legislation, to be effective, should take this into consideration.

▼ ▼ ▼

Test of Water-Walled A-Type Marine Boiler

TO SERVE the S.S. Santa Paula and S.S. Santa Elena of the Panama Mail Steamship Company, Foster-Wheeler Corporation is building eight 4,900-sq.ft. A-type, 450-lb. water-tube boilers. These boilers differ from the usual A boiler in that two rows of water-wall tubes form the sides of the furnace, as shown in the illustration. These tubes, as well as those in the first rows of boiler tubes, are 2 in. in diameter, while the remainder of the tubes are 1½ inches.

The superheater, of convection type, is placed close enough to the fire to give a fairly constant steam temperature regardless of the boiler loading. The economizer sections are installed at the back of the tube banks instead of above the boiler, as is often done, thus permitting the height of the furnace to be increased without projecting the economizer above the fireroom ceiling. This particular type of economizer provides for the maximum heating surface exposed to the gases, with a comparatively small area for the flow of the water, resulting in a relatively high water velocity through the economizer. This should decrease any tendency for corrosion that might be caused by oxygen in the feed water. It also makes possible an efficient contraflow action, water being pumped downward through the economizer at a velocity sufficiently high to prevent recirculation, while the gases flow upward past the heating elements.



Cross-section through one of the boilers

The air required for combustion of the oil is blown downward from the top of the rear furnace wall in a double steel casing, thence under the boiler furnace floor and up over the front wall before it reaches the burners. The air flow cools these surfaces and eliminates a large portion of the radiation losses customarily encountered in boilers.

The boiler dimensions are as follows:

Boiler heating surface, sq.ft.	4,910
Economizer heating surface, sq.ft.	3,024
Superheating surface, sq.ft.	1,955
Total heating surface, sq.ft.	9,889
Furnace volume, sq.ft.	1,120
Maximum designed boiler pressure, lb.	450
Pressure at superheater outlet, lb.	400
Steam temperature, deg. F.	750

The results of a test at the factory are as follows:

Date of tests, Dec. 11, 1931

No. of test	9
Steam pressure in drum, lb.	421
At superheater outlet, lb.	392
Final steam temperature, deg. F.	755
Superheat, deg. F.	310
Steam per hour, lb.	36,250
Oil per hour, lb.	2,770
Pound steam per pound of oil	13.1
CO_2 in uptake, per cent	14.4
Temperature gases in uptake, deg. F.	309
Temperature of feed water entering economizer, deg. F.	153
Temperature of feed water leaving economizer deg. F.	271
Moisture in steam, per cent	0.8
Heat added per lb. of water, B.t.u.	1,262
Heat added per lb. of oil, B.t.u.	16,600
Heat in fuel per hour per cu.ft. combustion space, B.t.u.	47,700
Calorific value of fuel oil, B.t.u. per lb.	18,900

HEAT BALANCE

Over-all thermal efficiency, per cent	87.4
Sensible heat loss, per cent	5.2
Latent heat loss, per cent	5.4
Radiation and unaccounted for, per cent	2.0
	100.0

An unusual feature is that these boilers are being built out of doors (at the Carteret, N. J., factory) and the tests are likewise being conducted in the open air.

Automatic Control Adjusts Air to Mixed Gases

Apparatus developed in Germany automatically proportions air to heating value of changing mixture of two gases. This system may find application to boiler furnaces using two fuels simultaneously

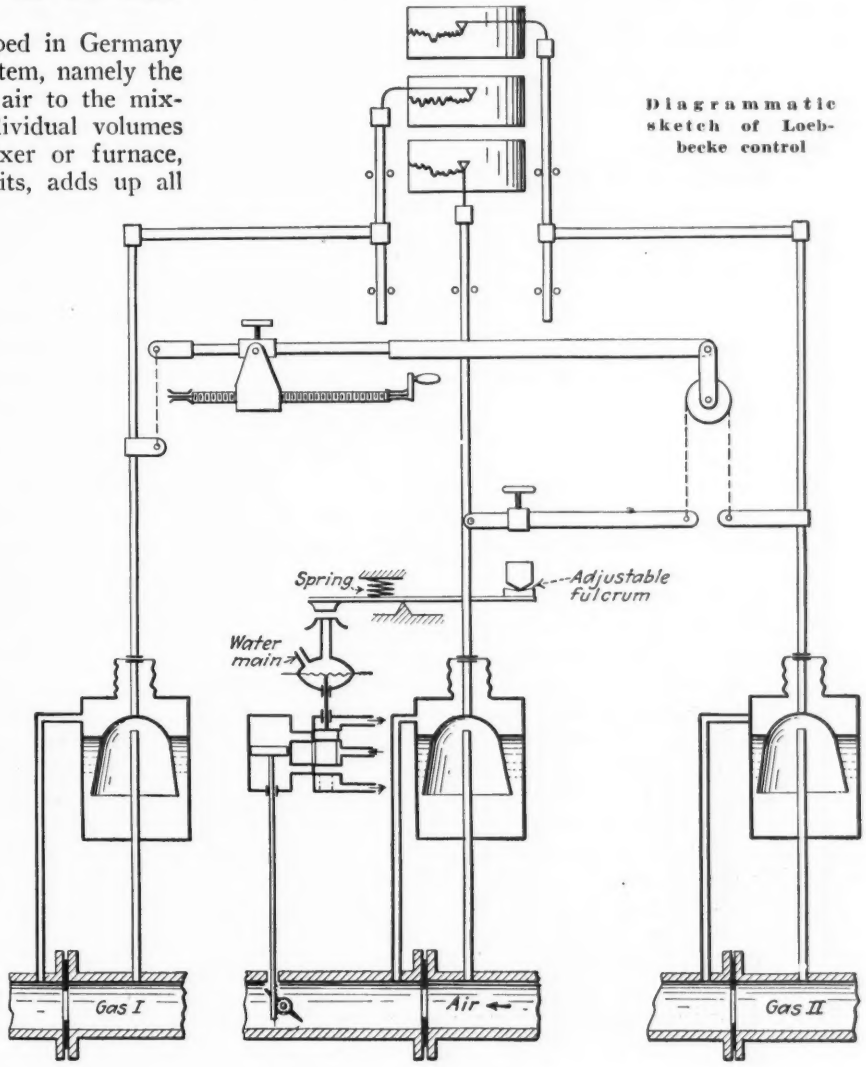
By KARL A. MAYR

IN *Power*, September 2, 1930, was a short description of a control apparatus designed to maintain a certain predetermined relation between the volumetric amounts of two gases which enter a gas mixer. The mixture is used as fuel for furnaces. If one would replace one of the two gases, say the coke-oven gas, by air, the arrangement could be used for a crude control of the combustion air for the blast-furnace gas.

A control apparatus has been developed in Germany which takes the next step in such a system, namely the apportioning of the correct amount of air to the mixture. This apparatus measures the individual volumes of the different gases going to the mixer or furnace, transfers these into equivalent heat units, adds up all heat supplied by the individual gases and controls the flow of combustion air in proportion to the total heating value of the mixture. Provisions are made for readjustment whenever the heating value of one or the other gas changes. A check-back is provided on that part of the apparatus which controls the air supply. This check-back is directly responsive to the air flow and definitely stabilizes the whole control process.

In industrial, particularly metallurgical, furnaces exact temperatures and flame shapes are required. These demands change with the progress of the individual process and at certain times more of one kind of gas will be admitted to the mixing chamber or furnace and the other gas will be throttled and vice versa, to comply with the temperature and flame shape requirements of the process. For this reason and also because the pressure in the supply mains and the heating value of the individual gases is in most practical cases subject to variation, the composition of the gas mixture will change continuously and so will the heating value and the air required to burn the mixture efficiently. This situation makes a sustained correct adjustment of the combustion air extremely difficult.

The new control method regulates automatically the total air required by the gas mixture, no matter in what manner the proportion of the individual gases is changed. The apparatus calculates automatically the total amount of air which is required at any time to burn the gas mixture, which changes in its composition, and takes care that this amount of air is admitted to the furnace. Whereas the operation of a mixed gas furnace by hand or control apparatus for the individual gases is almost impossible or at least only possible in a very crude way, the new control apparatus secures an automatic operation and maintenance of the desired temperatures and best combustion efficiency.



Diagrammatic sketch of Loebbecke control

The apparatus records at the same time the flow of the air and of each individual gas on a single record sheet. The whole arrangement is extremely simple, sturdy and not expensive and has given satisfactory service in one of the largest German steel plants.

The inventor of the device is Dr. Loebbecke, an expert in industrial heat economy. It is his opinion that the use of ready mixed gas will be more and more restricted to furnace groups which cannot be operated satisfactorily with blast-furnace gas alone. In such cases the mixing of the total amount of gas demanded by the whole plant is controlled by one single control apparatus, which should maintain the heating value and the pressure of the gas mixture rather than the volumetric proportion of the gases.

In some cases the mixture of the individual gases takes place in the furnace itself and it is desirable to have an automatic control which regulates the air supply to the furnace in proportion to the total heating value of the gases going to the furnace, or maintains a predetermined heating value and gas pressure. A control responding only to the gas volumes and not taking care of the heating values would not be sufficient.

For delicate metallurgical and other industrial furnaces the use of mixed gas is gaining more and more ground. This is mainly because of the ease with which the heating value can be adjusted for best serving the process and at the same time the utmost use of available cheap or waste gases can be made. The introduction, however, is somewhat hindered by the difficulty of controlling the air supply and maintaining steady temperature (and efficiency) conditions. The Loebbecke control system effectively fills this gap and overcomes the difficulties encountered when using different kinds of fuel simultaneously.

The diagram on page 63 shows, in a schematic way, the application of the Loebbecke method to the control of the combustion air for two different gases.

The differential pressures of flow meters for each gas act on floating bells of parabolic shape. The linear movement of shafts or the like connected to the bells is then in proportion to the amounts of the individual gases flowing to the furnace or to a mixing chamber. The movements of the bells for the two gases are added up and transmitted to a weight which operates by way of a level an outlet nozzle for a fluid of substantially constant pressure (water main). Depending on the opening of this nozzle, the water pressure in a chamber above a diaphragm changes. This diaphragm operates a pilot valve, which by way of a servomotor controls a butterfly valve in the air supply line.

The position of the fulcrum for the lever transmitting the movement of one gas meter bell is adjustable to take care of varying heating values. The fulcrum of the lever for transmitting the total of the movements of the two gas meter bells to the apparatus for controlling the air supply is also adjustable. This permits a change of the amount of excess air.

The air-supply line is also provided with an air meter operating a bell of parabolic shape. The movements of this bell are used to check back on the movement for operating the air supply and to stabilize the system.

The movements of the bells are used at the same time for indicating and recording the amounts of the individual gases and the air going to the furnace or mixing chamber.

The over-all space requirements of such an apparatus, including recorders, is about 3 ft. by 3 ft. 6 in.

Instructions for the Care and Operation of Hoists

By MARIN PHILLIPS

THE PURPOSE of the following instructions is to assist in maintaining hoists in first-class mechanical condition, thus insuring continued operation of the equipment and safety to the operators. The frequency of making inspection will vary with the different parts of the equipment. Certain parts of hoists that are in regular service should be inspected daily, while others need be given attention every six months. The following inspection schedule is used in one large plant with good results:

Daily

Inspect motor bearings to see that they are filled with oil. Also note if oil rings are in place.

Inspect hoisting rope for broken strands and loose cable clamps. Inspect cable drum to see that the cable winds up properly in the grooves. Note if the sheave turns freely on the load hooks. Examine load hook carefully to see that the nut that holds the sheave journal in place is tight. See that locking cotter pin is in place. See that trolley wheel makes good contact with the trolley wire. See that all controllers return to the off position when the operating ropes are released.

Wipe off any oil drops clinging to motor carriage, gear case or other parts. Also clean out oil drip pan.

Inspect mechanical brake on carriage to see that it does not coast when the power is shut off, but it must not be so adjusted that the carriage will stop suddenly enough to start the load swinging.

For safe operation the brakes must be kept properly adjusted and in good condition. Note condition of electrical hoisting brake. Adjust it so that it fully releases the mechanical brake when power is applied to the hoisting motor. Adjust the mechanical brake so that it will safely hold the load, but not closely enough to stop the load with a jerk when it is being lowered. Inspect limit switches to see that they are in good condition and working properly.

Inspect controller fingers and contacts. Keep them adjusted, tightened, clean, and making good contact. Change any badly burned contacts and fingers. Inspect fingers for broken springs and shunts. Keep contacts and fingers lubricated with vaseline. Keep arc barriers in place. Inspect for loose connections, screws, bolts and other parts.

Weekly

Inspect main bolt supporting the hoist and see that the nut is locked with a cotter pin. Blow copper and other dust out of resistance tubes and controllers. Clean the motor thoroughly, blowing out all dust, grit and dirt that have collected in the windings. Wipe off all oil, lint and dirt around the inside of commutator and brush-holders to remove all copper and carbon dust.

See that brushes are properly set and spaced on the commutator. See that brush-holder yoke is tight. Note if the brushes work freely in the holders. If not, clean them and see that the spring tension is sufficient to insure good brush contact on the commutator. In case of sparking at the brushes, shift them first in one direction and

then in the other until a place of minimum sparking is found. See that the oil well covers and end dust cap are kept in place.

Fill all grease cups with clean grease. Screw the caps down enough to insure the grease feeding to the bearings. If Alemite fittings are used, force a little grease in them to insure proper lubrication. See that all open gearing is lubricated with heavy grease. Note hoisting cable to see that it is properly lubricated. Lubricate load-hook bearing. Use the best oil and grease. Inspect the gear casing to see that the proper oil level is being maintained.

Inspect motor pinion, key and set-screws to see that they are tight. Note condition of carriage drive gear and track wheels. Also all keys and set-screws on shaft between hoist motor and gear case.

Monthly

Inspect the air gap between armature and field poles. Make an insulation resistance test of motor, controllers, brake coil and trolley wire. Note condition of bolts supporting the hoist track.

Every Three Months

Change oil in motor bearings and inspect gearing. Remove end plate on mechanical brake and inspect it carefully.

Every Six Months

Gear cases are to be taken apart for a thorough inspection of all moving parts and bearings and all necessary repairs made. Before reassembling the parts, wash the gear case out well with kerosene. Use new gaskets. When making this inspection, pay particular attention to all oil pipes, grooves and holes to see that none is plugged up. When the inspection is completed, and the necessary repairs made, refill the gear case to the proper level with fresh, clean oil. See that all gaskets and oil plugs are tight.

Operation

Use care when stopping hoist so as not to throw the controller to the reverse position before motor stops. When lifting loads, be sure to have the load directly under the load hook. If this is not done the load will swing when picked up, putting undue strain on the hoist and causing the cable to wind up with crossed turns. The swinging load and crossed cable are unsafe for the hoist operator.

Do not leave loads suspended on the hoist any longer than is necessary. Do not hoist materials over the heads of workmen. Do not pile materials higher than is designated as a safe value for the floor or wall. Do not leave the hoist in places where the load hook and carrier beam will hang in aisles and passage ways.

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Emergency Operation Of Sluice Gates

By R. F. EMERSON

SOMETIMES sluice gates must be lowered quickly on failure of power. There are several methods for doing this electrically. These gates are often operated by intermittently rated squirrel-cage motors designed for high starting torque. On failure of power it may be imperative to lower the gate at two or three times the usual hoisting speed. With a storage battery it is possible to excite one phase of the motor's startor and lower by dynamic braking, but the speed will doubtless be too low. The speed, of course, is fixed by the resistance of the motor's rotor.

If the motor is of the wound-rotor type, it is possible to excite one phase of the stator by direct current and to get practically any desired speed by varying the resistance in the secondary. But the regulation is poor,

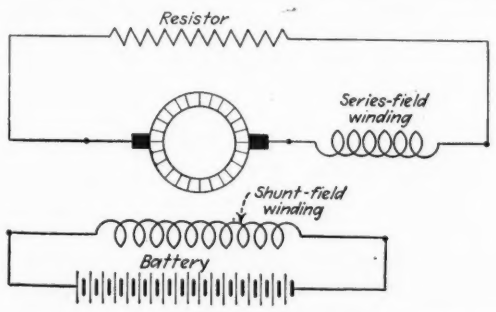

Fig. 1—Direct-current series motor with a light shunt field winding is geared to a hoist and short circuited through a series resistor to give dynamic braking for lowering sluice gate

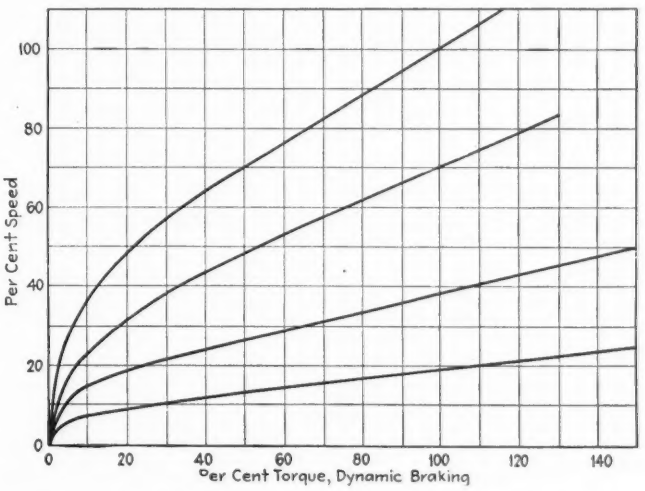

Fig. 2—Speed-torque curves obtained with the connections, Fig. 1, with different values of series resistance

particularly at high speeds, so that changes in overhauling load due to immersion of the gate in water or to pressure of the water against the gate will have considerable effect on the speed.

These difficulties can be overcome by gearing an intermittently rated, series-wound, direct-current motor to the hoist and short circuiting the motor terminals through a resistor, as shown in Fig. 1. A light shunt field can be connected across the battery to insure that the voltage builds up each time. Various speeds can be obtained by varying the amount of this resistance as indicated in Fig. 2. Of course, the load must always be sufficient to overhaul the direct-current machine, as otherwise the torque is zero. However, a sluice gate usually weighs several tons and the conditions of operation are such that this scheme of connection can usually be successfully used.

Application of Thermal Cutouts To Motor Protection

By H. D. BRALEY
Assistant Engineer, Protective Equipment
The New York Edison Company

A previous article, Nov. 17, 1931, described the different type of thermal cutouts and their characteristics. In this story, how to use these devices for motor protection and their limitations are discussed

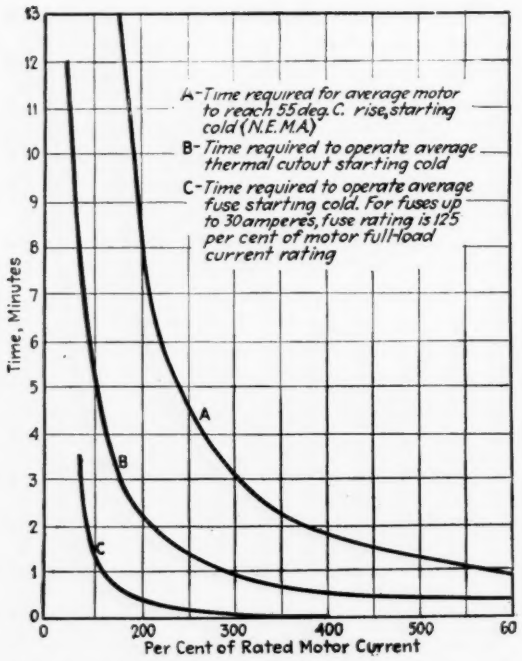
A-Time required for average motor to reach 55 deg. C. rise, starting cold (N.E.M.A.)
B-Time required to operate average thermal cutout starting cold
C-Time required to operate average fuse starting cold. For fuses up to 30 amperes, fuse rating is 125 per cent of motor full-load current rating
Time, Minutes
Per Cent of Rated Motor Current
A
B
C

Fig. 1—Time-temperature characteristic of a motor compared with the time required by a thermal cutout and a fuse to function

TABLE I — COMPARISON OF STARTING CURRENTS AND STARTING TORQUES OF SQUIRREL-CAGE MOTORS WITH DIFFERENT TYPES OF STARTERS

Motor, Hp.	Synch. Speed, R.p.m.	Current in Line With Blocked Rotor Per Cent of Full-Load Current: Full-Voltage Starter	Compensator: 80 Per Cent Tap	Compensator: 65 Per Cent Tap	Compensator: Using Primary Resis. Starter	Starting Torque, Per Cent of Full-Load Torque: Full-Voltage Starter	Compensator: 80 Per Cent Tap	Compensator: 65 Per Cent Tap	Compensator: Using Primary Resis. Starter
60-Cycle, Standard General-Purpose Motors									
1 to 75	3600	780	500	330	640	185	118	78	124
1 to 100	1800	710	455	300	580	175	112	74	117
125 to 200	1800	710	455	300	580	110	70	46	74
1 to 100	1200	660	422	279	540	165	106	70	110
125 to 200	1200	660	422	279	540	110	70	46	74
1 to 125	900	570	365	241	467	155	99	65	104
5 to 100	720	520	333	220	426	135	86	57	90
5 to 100	600	500	320	211	410	125	80	53	84
25-Cycle, Standard General-Purpose Motors									
½ to 75	1500	800	512	338	656	235	150	99	158
¼ to 75	750	650	415	275	533	215	131	91	145
7½ to 75	500	760	486	320	623	230	147	97	155
60-Cycle, High Starting-Torque, High-Resistance, Low-Starting Current, For Flywheel Loads									
5 to 100	1200	540	346	228	443	290	185	122	195
	900	520	333	220	426	280	180	118	188
60-Cycle, High-Starting-Torque, High-Reactance, Low-Starting-Current. For Pumps, Compressors and Similar Loads									
3 to 50	1800	490	314	207	400	240	154	101	161
	1200	470	300	200	385	235	150	99	158
	900	430	275	180	352	230	147	97	155
60-Cycle, Normal-Starting-Torque, Low-Starting-Current. For General-Purpose Use									
7½ to 50	1800	490	314	207	400	160	102	68	107
	1200	480	307	203	393	160	102	68	107
	900	450	290	190	370	160	102	68	107
60-Cycle, Single-Phase, General-Purpose Motors									
½ to 10	3600	400	...	...	...	290	...	...	...
	1800	360	...	...	...	295	...	...	...
	1200	340	...	...	...	275	...	...	...
	900	280	...	...	...	255	...	...	...

A THERMAL CUTOUT will operate on sustained overloads in sufficient time to protect a motor against dangerous overheating, but it will not function on harmless short-time overloads. It therefore prevents unnecessary interruptions which commonly result when the ordinary type of fuse is used. This is its chief advantage for motor overload protection, since it permits the motor to operate nearer the limit of its ability. For example, a motor started cold or operated for some time under light-load conditions is capable of carrying a greater overload than if it had been operated under continuous full load. The same is true of ambient temperature, for if the surrounding air temperature is low a greater load can be carried than if the temperature is high.

Fig. 1 illustrates the benefits to be obtained by using a protective overload device which is compensated for the thermal capacity of the motor. Curve *A* shows the time-current heating characteristics of the average general-purpose motor, the heating being limited to a value corresponding to the maximum temperature which the motor can stand without injury. Curve *B* indicates the time required to operate the average thermal cutout, and curve *C* the time required to blow an ordinary fuse. It should be clearly understood that these are average characteristics and that individual motors, cutouts and fuses may vary from those given by these curves.

Open-Phase Protection

The thermal cutout also provides good protection against single-phase operation of polyphase motors. When one phase of a polyphase motor is opened the motor will continue to operate single phase. At 100 per cent load the motor will take from 150 per cent to more than 200 per cent of its normal rated current from the remaining phase and soon reach a dangerously high temperature. The thermal cutout will protect the motor against currents of this magnitude if properly applied.

TABLE II — CUTOUT AND FUSE RATINGS FOR MOTOR CIRCUIT PROTECTION*

Ratings in Amperes

Thermal Cutouts	Maximum Size Fuses 250-Volt Circuits	Maximum Size Fuses 550-Volt Circuits
0.8 to 2.5	70	35
3.0 and 3.6	100	40
4.3 to 6.0	120	75
7.1 to 14.0	150	100
16.6 and 20.0	200	100

*Comparative ratings of General Electric plug-type cut-outs and standard enclosed fuses required for back-up short-circuit protection. The fuse ratings given are the maximum, smaller sizes may be used.

If the load is less than 50 per cent of the rated motor capacity the thermal cutout will not operate, but there is no danger of damage under this condition.

Where switches are used for starting alternating-current motors by throwing them directly across the line at full voltage the momentary current inrush may vary from 300 to 800 per cent of the normal full-load value, depending on type and speed of the motor. Fig. 2 is an oscillograph record of the starting current inrush of a squirrel-cage general-purpose motor where the starting current transient lasted for approximately 5 sec. Smaller motors may come up to speed in one or two seconds, while larger motors may require longer time.

Table I shows the starting currents and torque developed by motors of various types for both full- and reduced-voltage starting. These are average values for standard motors of the horsepower range indicated, at rated voltage and frequency.

It is essential, therefore, that protective devices used with full-voltage starting switches have sufficient time lag to permit the motor to come up to speed. Thermally lagged protective devices such as the thermal cutout are particularly adapted for this service as the time-current characteristics are determined principally by the stalled-motor condition. While the starting current may be equal to the locked-rotor current at the first instant, it quickly drops to normal running value, so that the effective heating during this period is harmless and will not operate the cutout. The cutout will operate, of course, if the motor fails to start or comes up to speed very slowly, on account of abnormal-load conditions.

The normal rated capacity of plug-type cutouts is limited to 15 or 20 amp., 600 volts alternating-current, although some manufacturers assign higher ratings at lower voltages and also for cutouts of the cartridge type. Application of the plug-type devices is therefore limited to single-phase motors with ratings not exceeding 1½ to 2 hp., 110 volts or 3 hp., 220 volts and polyphase motors with ratings ranging from 3 hp., 110 volts to 15 hp., 550 volts.

The size of cutout selected for a particular motor is such that the motor will be permitted to carry 10 to 25 per cent overload continuously. Some manufacturers mark their cutouts with the motor full-load current with which they are to be used, others give the rating of the cutout itself but furnish a reference table giving the corresponding motor full-load current to which the cutout is applicable. The essential point in any case is to make sure that the cutout is adapted for use with the particular motor to which it is applied.

Short-Circuit Rating

Due to the limited rupturing capacity of this device, the Fire Underwriters' code requires that fuse or instantaneous overload circuit breaker protection be provided at the origin of any branch circuit supplying a motor equipped with thermal-cutout overload protection. In the larger ratings the corresponding fuse rating required is in the order of 400 to 500 per cent of the cutout rating. Where a group of motors is supplied from one branch circuit the back-up fuse rating or circuit breaker setting must be selected with respect to the smallest size of thermal cutout used on that circuit. The maximum size of fuse rating is marked on each cutout to insure that the proper back-up protection is installed for protection against short circuit. Table II gives comparative ratings required for General Electric plug-type cutouts.

The degree of accuracy, that is, the variation in tripping time between cutouts of the same make and rating and between those of different makes but of the same rating is comparable with that found in standard inclosed fuses. Manufacturing limits allow a maximum variation in operating time of plus or minus 5 per cent from rated performance, which is well within permissible limits for an overload protective device for this service. It must be realized that devices of this kind are not comparable with high-grade thermal relays, but neither are they comparable in price. Although somewhat more expensive than ordinary fuses, the increase in cost is generally justifiable in view of their advantages for protection of small motors.

The sensitivity is comparable to fuses and is within the necessary limits to provide satisfactory overload protection for small alternating-current motors. Devices of

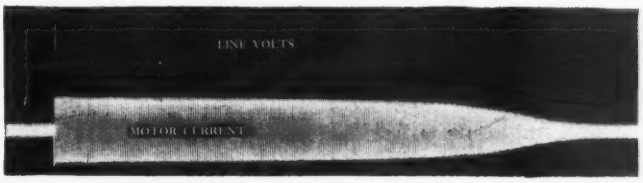

Fig. 2—Oscillograph record of the starting-current taken by a general-purpose squirrel-cage motor

this kind are not adapted to protection of circuits nor are they suitable for short-circuit protection, hence selectivity with other protective devices need not be considered. They do provide selective action in the sense that they will operate before the motor attains a dangerously high temperature due to overload.

The reliability of thermal cutouts is good, although somewhat less than a fuse, since the heater and spring mechanism constitute additional current-carrying parts which may fail occasionally, particularly under short-circuit conditions.

The first cost of thermal cutouts is in the order of two to three times that of ordinary renewable-type cartrige fuses of the same rating. As this is only a small fraction of the motor cost it is not an important item when considered in respect to the improved protection. Still more important is the reduction in lost-time shutdowns resulting from harmless short-time overloads.

The fusible element is the only part ordinarily requiring replacement. The cost of refills is practically the same as for renewable fuse links. If a a short circuit occurs on the load side of the cutout, the entire device will probably require replacement.

TABLE III — SUMMARY OF THERMAL CUTOUT CHARACTERISTICS

Application — Protection of small alternating-current motors against overload.
Rating — 600 volts and currents up to approximately 20 amp.
Normal Rated Capacity — 110 to 125 per cent rated current continuously.
Overload Capacity — (See characteristic curve).
Short-Circuit Capacity — None. Back-up protection with fuses or instantaneous tripping circuit breakers must be provided.
Reliability — Good, but less than fuse.
First Cost — Two or three times ordinary renewable fuse of same rating.
Maintenance — Low. Normally requires replacement of refill element only except when subjected to short circuit.
Accuracy — Plus or minus 5 per cent of rated capacity.
Sensitivity — Good.
Selectivity — Not adapted for circuit protection, but will select with time-temperature characteristics of motor to which it is applicable.

CURRENT COMMENT

Precautions in Boiler Operation

WITH REFERENCE to the comments on "Operating Non-Return Valves," in the Nov. 10, 1931, number, I should like to add another precaution. In draining a boiler not under pressure be sure that the try cocks on the water column are open. Otherwise the vacuum may hold a portion of the water in the boiler. An experience while an apprentice impressed this fact on me. The engineer whom I was assisting was blowing down a boiler preparatory to regrinding a blowdown cock. Observing the open end of the blowdown line, he judged all the water to be out of the boiler, shut the blowdown valve and slacked the bolts on the cock. The plug flew out and the hot water scalded us both.

Too much care cannot be used when working on a dead boiler. The procedure listed in the article mentioned might be supplemented:

The boiler must be thoroughly ventilated before a man enters the drums.

Compressed air lines and tools must be in good condition.

Extension lights are not to be handled by the man in the boiler and all cords and fuses must be previously inspected.

Boiler maintenance men should work in pairs for safety.

Gloves and goggles with shatter-proof glass save many calls for first aid.

It has been my experience that more men are killed and injured while working on boilers out of service than while operating boilers under steam. As a rule, operators do not use the safeguards in boiler maintenance that conditions and experience warrant. T. J. DONNELLY.

Kingston, Ont.

The Practical Man Vs. The Theorist

THE ARTICLE entitled "The Practical Man Vs. the Theorist," by Orville Adams, which appeared in the Dec. 8, 1931, number, is interesting, and I may say timely, for there seems to be a general misunderstanding of the relationship between practice and theory, and of the meaning of the words themselves, by many presumably educated engineers. Mr. Adams has clarified the matter, and to the young engineer what has been written is well worth remembering. However, I should like to add a few comments, not so much on Mr. Adams' article, as on the subject itself.

There is one word more that bears a relationship to the subject at issue and that is "hypothesis," thus forming a trinity, "practice, theory and hypothesis." Many times the word "theory" is used, when the word "hypothesis" is really meant. Theory is based on practice and experience; it is practice and experience written down. Theory can only follow practice and experience and must always agree with them.

On the contrary, hypothesis precedes practice and experience, and if practice and experience prove a hypothesis correct, then it can be written down as theory to whatever it may have been applied. Any supposition, whether probable or not, that is not founded on facts determined by practice and experience is a hypothesis.

Theory is determined by experiment, observation and thought. Not the simplest work can be done without theory. When we hear a man say (as we frequently do) that "theory and practice do not always agree" we should know that what he intends to convey is that hypothesis and practice do not always agree. A hypothesis may or may not turn out to be true; it must first be tested by practice and experience. A theory must of necessity always be true, so it seems unnecessary to say "every true theory is a fact," as though there were some other kind of theory than "true."

By the way, the larger dictionaries' definitions of theory and hypothesis are somewhat confusing to the layman. CHARLES J. MASON.

Brooklyn, N. Y.

Diesel Cooling-Water Systems

THE ARTICLE by Louis R. Ford in the Sept. 29, 1931, number was read with the utmost interest. The realization that approximately 3,000 engines are being installed a year with an average horsepower of probably 150 each brings home with a certain amount of force the fact that this is a relatively important subject. It is entirely probable that water-softening equipment could be installed in the most of these diesel installations.

Cooling diesel engines can hardly be discussed without also discussing water softeners. About 70 per cent of the area of the United States contains water which carries such quantities of scale-forming soils as to warrant softening.

Salts percipitate under the influence of heat. As scale forms, operating temperatures become higher and in consequence the accumulation of sediment and scale become more rapid. Carbon-dioxide gas exists in all natural waters, and the solubility of calcium, magnesium and iron bicarbonate salts results from the presence of carbon dioxide in the water. Upon heating, the carbon-dioxide gas is driven off, while the salts settle and precipitate out as calcium or magnesium carbonate and the iron separates out as iron hydroxide. As these are insoluble in hot water as well as in cold water, they form scale rapidly. The sulphates, nitrates and chlorides, so often found in natural waters, form permanent hardness which deposits upon the jackets of diesel engines in the form of scale. Cooling diesel engines involves both chemistry and cost, therefore.

Where a cooling tower or spray pond is to be used for the open system, the additional cost of a softener is only a small item of first cost, $150 to $600, depending upon the size of the job, and in any case is rapidly paid off by the operating economies.

A fact which should be emphasized is that if chemical treatment such as a compound or lime soda is used to prevent scale, the compound simply separates the scale-forming salts from the water. These will collect as

sludge and bake on the cylinder head and cooling jackets in the form of scale. The method, therefore, is unsatisfactory. As, with a lime-soda softener, the cold process must be used, the hardness in the water will not be reduced to less than 5 gr. A 5-gr. water will form scale in the cylinder heads; therefore compounds and chemical treatment are unsuited for diesel purposes.

The cooling water should be filtered as well as softened—a water softener without a filter can hardly be considered an adequate installation for diesel operation—since salt, sand, grit and other foreign matter carried in through the jacket by unfiltered water tend to pack and form scale under the influence of heat, acting as an insulator and forming a nucleus around which sedimentation can adhere and build up.

The capacity of a zeolite softener depends to considerable extent upon the rate at which the water flows through it. Quite a saving in first cost can be obtained, therefore, by using a smaller softener and having it charge the water storage tank at a low rate of charge rather than at the rate of water discharge through the engine. Since storage tankage costs less per cubic foot than softener capacity, generous storage capacity not only lowers softening costs, but also provides a larger reserve water storage. The small zeolite softener for diesel work will usually have to be regenerated once in 24 hr. On a basis of 10 gr. of hardness in the water, 5 lb. of salt, with salt costing $8 per ton, gives a treating cost of 2c. per 1,000 gallons.

The horsepower of a diesel engine may be reduced as much as 30 per cent, due to the accumulation of scale within the water jackets. Since this accumulation is gradual, the decrease in engine capacity as represented by the dollar investment per engine horsepower should be charged against the cooling system.

The loss of revenue or the loss of production while an engine is shut down for cleaning of the jackets or for replacement due to fracture should rightly be charged to untreated water. The presence of scale may easily result in a temperature increase of 200 deg. F. or more where hard water is used instead of softened water.

Gradual building up of scale within the pipes, which are not readily accessible, increases the cost of pumping. The greater power required by many plants for circulating the cooling water due to this cause alone would pay for the original cost of a softener within a short period of time. The decrease in power consumption for cooling purposes will almost invariably more than pay for the necessary salt required for regeneration.

In many sections of the country the marked alkalinity of the water causes the spray pond and cooling tower to be contra-indicated, since the evaporation of the water causes the alkali or lime to become concentrated by evaporation, depositing not only upon the inside of engine jackets, but upon the inside of all piping. In such cases the use of heat exchangers should be given careful consideration. The use of radiators in a closed system means that the cooling water never comes into contact with the air, so evaporation and lime deposits are minimized. Another advantage of radiator cooling is that less space is required for cooling purposes.

After frequent recirculation water which is comparatively soft suffers a certain amount of evaporation until it reaches a point of saturation where the mineral salts precipitate out. Even with a closed system where the water is relatively soft it is necessary to be always on the watch against increasing hardness, hence scale formation due to evaporation and increasing concentration. Consequently, it is necessary from time to time to blow off the open cooling system, just as it is necessary to blowdown a boiler, to lessen the concentration of dissolved solids and replace the blowdown by make-up water which has been softened, or unsoftened, according to local requirements. Spray ponds should be completely drained off from time to time and refilled with fresh water.

It can be seen that Mr. Ford wrote none too strongly when he said, "In view of the operating troubles that have been caused by scale in some existing engines it would not be unreasonable for engine manufacturers to refuse to supply an engine installation in a locality where the water conditions are known to be bad unless a satisfactory soft-water system be provided for in the installation plans." Diesel operating costs would often be greatly improved if the softener were put in at the start instead of only after trouble and expense have occurred.

Elgin, Ill. E. F. ECKEL,
Elgin Softener Corp.

Wanted—A Feed-Water Moses

RELATIVE to the letters of Mr. Swift and Professor Straub in the Sept. 29 and Nov. 10 numbers of *Power*, respectively, a large part of the writer's job is to deal with the conditioning of boiler water in plants scattered over many states. During a month somewhere around 2,000 daily water analyses from these plants are reported and checked. The accompanying tabulation shows the results being obtained in different districts:

State	Caustic, Gr. per Gal.	Alk. not Caustic, Gr. per Gal.	Concentration
Wisconsin	4.4	8.8	4.1
Illinois	5.9	5.2	2.3
Missouri	3.0	6.0	...
Mississippi	12.0	4.0	5.7
Tennessee	3.5	5.4	3.0
Michigan	3.7	9.0	4.4
Pennsylvania	5.4	8.8	6.0
Minnesota	2.9	10.4	3.1
Idaho	1.2	2.4	3.3
Colorado	2.2	7.0	5.4
Washington	4.8	9.6	4.3

These data, being typical of the reports received from all the plants, show that the degree of control which Mr. Swift recommends is being carried out. The steam generated in these plants is clean and the boilers are clean.

It might be interesting to the readers to know that the average make-up in these plants is around 35 per cent. The average blowdown is 25 per cent of the make-up. Contrary to what might be expected, the chemical treatment required in these plants is not more than it was before the automatic continuous blowdown installations were made. The Wisconsin plants, generating an average of about 30,000 lb. of steam per hour, require less than 18c. worth of chemical treatment per day. The average hardness is 18 g.p.m. The loss due to continuous blowdown is negligible, as the heat is nearly all salvaged from the blowdown water.

Our experience is that regardless of the kind of raw water and regardless of the kind of treatment given the raw water it is necessary to control the causticity, alkalinity and concentration within the boiler if the best results are to be obtained. I think it is a good thing to have a target at which to aim, such as the boiler water condition suggested by Mr. Swift. W. H. ROBINSON.

Oconomowoc, Wis.

READERS' PROBLEMS

HEATING A SWIMMING POOL—*I have a large concrete swimming pool with no proper connections for heating water. At the deep end an 8¼-in. discharge pipe extends 35 ft. through a bank. There is a 6-in. drop in the pipe from pool to discharge valve, the valve being at the low point. Where the pipe enters the pool at the deep end there is 11 ft. of water above it. Would it be practical for me to run a steam line from an ordinary donkey boiler to this discharge line so as to feed steam to the pool through the 35-ft. discharge line and attempt to raise the temperature of the water in this way? Would there be danger of water-hammer in the line, and much loss of heat to the atmosphere? What pressure and size of steam line could I use?*

I wish to raise the temperature of 300,000 gal. of water 6 deg. F. and 14,000 gal. of make-up water 18 deg. F. each 12 hr., or approximately 1,425,000 B.t.u. per hour. What size boiler is needed? Is the plan of heating practicable? I do not like to consider a coil in the pool. O.M.W.

Answering the questions in sequence, it would not be feasible to heat the tank through the discharge pipe. There would be danger of extremely heavy water-hammer. The loss of heat to the atmosphere from the pipe should not be excessive, and the chief losses would be through evaporation from the pool surface, and through the walls. The steam pressure may be any value that other factors dictate. On the basis of 3,350 B.t.u. absorbed per hour per square foot of heating surface, the boiler should have approximately 425 sq.ft. of surface, or, as termed by some boiler makers, it should be rated at 42.5 horsepower.

The logical method is to heat only the make-up, raising it to such a temperature that it will offset the loss in the pool. This could be done in a heater, or the make-up could be passed through the boiler itself, so that the latter supplied hot water instead of steam.

PROTECTING BRASS WORK — *In our building there is much brass in the elevators, lobby and outside front wall. To keep this looking well lots of polish and labor are needed. Is it possible to coat this brass with some covering that will prevent oxidation?* G.H.

For the inside brass where not exposed to the weather a coating of collodion will eliminate the necessity of polishing. It is necessary to clean the brass of all grease and polish by using benzine. For the outside brass there are several lacquers that will prevent oxidation. For doors where the coating suffers from contact with passerbys, the lacquer will need to be renewed occasionally.

SPEED OF PISTON-TYPE FEED PUMPS—*How fast should a boiler-feed pump be run?* M.L.V.

The Hydraulic Society recommends that the speed in feet per minute of a piston of a boiler feed pump be held below the following values as maximum:

Stroke of pump, In.	Feet per Min.
3	18
4	22
5	24
6	26
8	30
10	33
12	39

General service pumps under low heads may be run 50 per cent faster.

CORRODED STEEL STACK—*One of our 42-in. x 78 ft. steel stacks shows corrosion at the horizontal, or round-about, seams. Is it possible to seal the leaks without replacing the damaged sections?* C.F.G.

If the corroded spots are not over two or three inches in diameter, it should be possible to repair the damage by applying iron cement. If there are not too many of the holes, sheet metal patches coated with the cement could be placed over the openings, with bolts and outer disks or crossbars to hold them in place.

HEATING-STEAM PRESSURE—*Where I am employed we have three 155-lb. 2,040-sq.ft. boilers. One of these will take care of the heat load. During the day we use exhaust steam for the heating system and heater at about 2 lb. I should like to know whether it would take more coal for the heating system to carry a low pressure on the boiler or carry a higher pressure, about 150 lb., and reduce it to 2 lb.* R.W.J.

Operating the boiler at 2 to 10 lb. pressure rather than at 150 lb. should give a better efficiency, that is, require less coal for a given heating load. This is for the reason that the lower steam temperature permits the boiler exit flue gas temperature to be lower.

WEIGHING COAL BY POWER CONSUMPTION—*Is it possible to weigh the coal handled by a bucket elevator by finding the kilowatt-hour consumption?* E.S.

This method of coal weighing has been employed in some power plants and found to check closely with actual scale readings. It is necessary to calibrate the elevator, that is, to ascertain the friction load and likewise the power consumption when a measured amount of coal is elevated. A second check employed in some plants is to ascertain the tonnage elevated during 1,000 revolutions of the head sprocket wheel. In one particular plant the two checked within 1 per cent. However, coal weighers are not expensive and are justified, since the tonnage received from the mine can be checked in a way acceptable to the coal shipper.

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Ferrous Hydroxide as A Corrosion Preventive

THE QUESTION

WE HAVE HAD considerable difficulty in the past with oxygen corrosion in the boilers. This difficulty was finally eliminated by the use of sodium sulphide in conjunction with an open heater to remove the last vestige of oxygen after the water leaves the heater.

In reading Power *I notice reference to the use of ferrous hydroxide for this purpose.*

Attempting to investigate this matter, I have been unable to get any information on the subject and would appreciate the advice of Power's *readers as to the relative efficiency and cost of this treatment compared to the sodium sulphide treatment.* H.P.S.

SATISFACTORY removal of oxygen is best obtained by mechanical means, not chemical. If the condenser is equipped for proper air removal, the condensate should be practically oxygen-free and any residue should easily be taken care of by an efficient deaërating heater. It is important also to insure that there is no opportunity for oxygen absorption by the water subsequent to air removal. If the feed tank is protected by a steam blanket and the feed system otherwise tight, oxygen will be excluded.

Chemical means of removing oxygen are open to several objections. In the first place, introducing a chemical such as sodium sulphite adds considerably to the soluble salts in the boiler and in addition may upset the SO_4 to CO_3 or PO_4 radical ratios being maintained. If ferrous hydroxide is to be used, the concentration of insoluble salts is increased, for ferrous hydroxide is only slightly soluble itself and the reaction product, ferric hydroxide, is insoluble.

Dependence on chemical means for taking up oxygen is open to the further objection that there is no means of assuring that the required reaction will be completed fully between the time the chemical is introduced and the water evaporated from the boiler. The presence of oxygen also indicates that some carbon dioxide may be present, and recent developments have shown that this is undesirable. Neither the sodium sulphite nor the ferrous hydroxide removes this and any other gases that may be present.

In short, it is believed that, in the long run, money expended for equipment to insure complete mechanical separation of air from the boiler water will more than pay for itself as against the cost of chemicals and increased heat losses from additional blowdowns.

It appears, from the question, that the boilers in question are sensitive to corrosion. Most boilers will show little if any corrosion with small amounts of oxygen, up to one cubic centimeter per liter, provided proper alkalinity of the water is maintained at all times. It is suggested that this feature of the boiler operation be investigated to determine if some of the corrosion cannot be corrected by accurate control of the boiler water alkalinity. T. W. SOLBERG.

Annapolis, Md.

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IN REGARD to the relative merits of ferrous hydroxide and sodium sulphite for the elimination of corrosion in boiler feed, in most cases it is more desirable to use sodium sulphite.

There is considerable difficulty in preparing a pure grade of ferrous hydroxide, in that this preparation must be done in airtight containers so that the material does not come in contact with air and become oxidized. In some cases ferrous sulphate can be used, but it requires additional alkalinity and in high-pressure installations the resultant sulphates formed may be very undesirable, both from carryover and scale-forming standpoints. Ferrous hydroxide also increases the suspended solids in boiler water, which is sometimes undesirable. The writer has noted that many silicate scales contain a very high percentage of iron, and it is possible, therefore, that the introduction of any iron salts into the boiler might be particularly objectionable if there is much soluble silica in the feed water.

Sodium sulphite does not require any undue amount of equipment for preparation, produces no suspended matter in the boiler water and does not destroy alkalinity. Ordinarily the increase in dissolved solids due to use of sodium sulphite is not as objectionable as is the increase of suspended solids accompanying the use of either ferrous hydroxide or ferrous sulphate.

Difficulties which will be encountered in the preparation of ferrous hydroxide, such as the amount of labor, the time consumed and the care necessary, would make this method just as expensive, if not more so, than the use of sodium sulphite.

Ferrous sulphate itself costs less than does sodium sulphite, so there would be cases where the use of ferrous sulphate would be more desirable from a cost standpoint. However, as stated before, the possible effect of suspended solids at the plant in question must be taken into consideration.

There are few cases, however, where corrosion cannot be prevented by proper control and application of alkalinity in the boiler feed and boiler water. Since this is the case, the use of either ferrous hydroxide or sodium sulphite should not be attempted except as a last resort.

J. A. HOLMES, *Director of Service,*
National Aluminate Corp.
Chicago, Ill.

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CHEMICAL DEAËRATION, or, more specifically, deoxygenation, through oxidation of materials placed in feed water, has been tried in a variety of ways in small boiler plants. Many substances might be used. Sodium salts have been used because of their cheapness, stability and freedom from scale-forming tendency.

Given suitable conditions, iron salts might be used with good efficiency of reaction, but with several attendant disadvantages. Ferrous hydroxide is not available commercially at the majority of chemical supply houses and even if it were it should cost several times as much a pound as either the sulphide or the sulphite of sodium. The oxygen-consuming power of a pound of the hydroxide is but little greater than that of a pound of commercial sodium sulphite, and theoretically only one-third as great as that of crystalline sodium sulphide. Furthermore, to insure application of the iron salt in the ferrous state it probably should be made fresh at the plant to eliminate any change to ferric iron in transit and storage. Even the purest ferrous hydroxide is but slightly water-soluble, and any undue exposure of it to air in putting it in solution would result in its reduction to insoluble ferric hydroxide.

Ferrous hydroxide is used as the oxygen-consuming agent in one type of deaëration apparatus. There, as has been suggested, it is generated as needed by the action of iron on ferric hydroxide, and is introduced into the feed water in a closed filter from which air is excluded. R. E. SUMMERS.

Corvallis, Ore.

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THIS IS simply a problem of mathematics and prices of each item. With sodium sulphide, the reaction depends on the presence of carbon dioxide in the air at the time of treatment. For this reason, while sodium sulphide does oxidize to a mixture of sulphide and sulphate of the soda salt, the reaction is too slow for practical work. With CO_2, which is universally present, the reactions are as follows:

Sodium sulphide plus carbon dioxide plus oxygen equals sodium thiosulphate plus sodium carbonate, or $2Na_2S + CO_2 + 4O = Na_2S_2O_3 + Na_2CO_3$. The second reaction is ferrous hydroxide plus water plus oxygen equals ferric hydroxide, or $2FeO_2H_2 + H_2O + O = Fe_2O_6H_6$ (or $Fe_2(O_2H_2)_3$.

Thus 156 parts of sodium sulphide would absorb 64 parts of oxygen, giving a ratio of about 2½ to 1; while it takes 180 parts of ferrous hydrate to absorb 16 parts of oxygen, a ratio of 11¼ to 1. At this rate the relative costs should be about 4½ to 1 to establish a parity. Fused sodium sulphide sells for about 4½c. per pound in casks. I do not find ferrous hydroxide quoted among the ordinary lists of commercial chemicals, probably because it is unstable and easily made, by adding caustic soda to a solution of iron sulphate, but I doubt if it can be made for 1c. a pound as it would have to be to compare with the soda salt.

The other advantages are with the ferrous hydroxide, if it be filtered from the water after being converted to the ferric form. It is easily filtered if kept neutral or on the alkaline side, but almost impossible to filter if on the acid side. This is my opinion, as I object to pumping sodium salts into my boilers. Although some authorities claim that they are beneficial, I still prefer pure water as a boiler feed.

My experience with an open heater is that it removes all gases from the feed water if vented at the top, provided it contains enough area to enable the gases to escape if carried slowly through the passages. This presumes that the water is at or near the boiling point when it leaves the heater. With sulphur waters, the effluent waters would show only faint traces of sulphur, usually none at all. This, and the fact that 12 to 15 per cent of the exhaust steam is condensed, are the sovereign claims for the open heater, for which I am an advocate, with reservations.

Cleveland, Ohio. L. R. BAKER.

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A Question for Our Readers

IN STUDYING the power plant of a contemplated office building the point has come up as to where the atmospheric relief valve for the engines should be placed. The engine room will be 632 ft. below the exhaust outlet on the roof. Back pressure in the heating season will be 5 lb. and in summer that due to the atmospheric. Will there be any difference in the engine back pressure between locating the relief valve on the roof or in the engine room? Ignoring the pipe friction, what will be the pressure at the engine when the relief valve is open during the summer? G.R.

Suitable answers from readers, if received promptly, will be paid for when published

Safe Practices in Operation Of Refrigerating Plants*

By GEORGE B. BRIGHT

SAFE PRACTICE in the operation of a refrigerating plant is obtainable only at the expense of careful attention to the various parts making up the system.

Refrigerating plants in the industrial group, while some of them contain many thousand pounds of refrigerant, do not present any great hazard, as they are usually in charge of a skilled operator, and, further, any great loss of refrigerant would prove costly from a renewal standpoint as well as impair the operating efficiency.

Most industrial plants are so located that they are not hazardous, except to workmen employed directly within them. Where the public comes in close contact with such plants it is usually some place remote from any part of the refrigerating system.

To insure safety to the employees, however, certain precautions must be observed.

Pressure gages should be checked often, at least every ten days, to be sure that they are registering the proper pressures.

Maintaining the Proper Condensing Pressure

The thermometer in the liquid line is the best check as to proper condensing pressure. If the pressure is not close to that corresponding to the temperature of the liquid leaving the condenser it is evident that there is air in the condenser or the condenser is dirty. This also applies when the temperature of the liquid leaving the condenser is more than a few degrees above the water temperature from the condenser. Thermometers in the suction lines should never show in excess of 5 to 8 deg. F. above that of the corresponding back pressure, and never below. If above, it shows suction superheat, which means that all of the low-side surface is not being used to the best advantage. If below the corresponding temperature, it shows that too much liquid is being fed to the low side, which results in freezing back to the compressor, with some danger of liquid shocks to the compressor.

All pipe connections should be kept tight and free from vibration. It should be remembered that no leak will ever "take up" with a refrigerant, no matter how small the leak may be.

The refrigerant should be kept free from oil and foul gas by purging the system.

Every pressure vessel that can be shut off should be equipped with a pop safety valve of "code" size and setting, and should be in proper working condition. If there is a stop valve between the vessel and the safety valve, the engineer should be sure that it is open. Most pressure-vessel failures are due to safety valves being out of commission and the A.S.R.E. code prohibits such stop valves.

Where plants are equipped with devices to stop the compressors, by means of pressure-limiting devices, the devices should be checked and tested at least once a month.

Shutting Down Compressor

In shutting down a compressor the suction stop valves should always be closed, and never opened until the machine is up to the desired speed when started again; then the opening should be gradual, to be sure that no entrained liquid is drawn into the compressor suddenly.

No valve in a refrigerating system should be opened or closed until the engineer has made a check as to what will happen. Many accidents have been caused by opening a valve allowing liquid to flow into the compressor, thereby wrecking the latter.

A full charge of refrigerant should be kept in the system at all times. Anything less than a full charge means the plant is operating at low efficiency on the evaporating surface.

Brine should be kept at the proper density, as a weak solution will freeze on the evaporator coils. The brine solution should be as near neutral as possible or slightly alkaline; acid or strong alkaline brine causes pitting and corrosion.

Gas masks should be in the plant and the operators should have monthly gas-mask drills. If necessary to remove the refrigerant from the system, it should always be placed in suitable containers in accordance with regulations or discharged with a suitable absorbent.

Accidents Usually Due to Carelessness

A careful check-up of 54 accidents reported in a number of ice plants reveals that only one was caused by the refrigerant. In that case the operator was burned by ammonia. This was pure neglect on the part of the operator, who carelessly opened a drain valve on a system under pressure.

Most of the accidents of recent years in the large industrial systems that have come under observation have been due entirely to careless use of equipment. A brine cooler, when filled with liquid, blew up when the inlet and outlet valves were closed; the stop-valve between the pop safety valve was closed. In another case a large quantity of ammonia was discharged from a plant when a discharge line made of light-weight pipe broke. Nothing would have happened beyond the plant if the bypass on the check valves had not been left open. Several thousand pounds of refrigerant was lost, whereas less than one hundred pounds would have been lost if the check-valve bypasses had not been left open.

Trouble and accidents will happen if refrigerating systems are not designed and constructed in conformity to a code, and if the installations are not made by competent licensed workmen.

*Abstract of paper presented before the Twentieth Annual Safety Council, Chicago, Ill., Oct. 12, 1931.

Three Western Utilities Plan $43,500,000 Construction

A TENTATIVE construction budget of $31,000,000 has been adopted by the Pacific Gas & Electric Company for 1932, according to A. F. Hockbeamer, president. It includes the three largest undertakings so far projected by any of the California utilities for 1932, namely, the construction of a 50,000-kw. steam plant in the southern end of the San Joaquin Valley in close proximity to the natural gas fields; a second natural-gas transmission line from San Jose to San Francisco, giving San Francisco a double line all the way from the gas fields; and the installation of 56,000 additional horsepower of hydro-electric energy on its Mokelumne, project. This budget, however, is elastic and may be varied, Mr. Hockbeamer said.

Expenditures in excess of $11,000,000 will make up the capital budget of the Southern California Edison Company, Ltd., for 1932, according to a statement made by R. H. Ballard, president, in announcing the company's general program for the new year.

"Conforming to the program which we laid down for ourselves two years ago, better than 50 per cent of our capital expenditures for 1932 will be used for the building up of distribution lines and substations," Mr. Ballard said. "Our generating capacity of 1,258,000 hp. in water power and steam generating plants and major transmission lines is adequate to take care of the needs of Southern California at the present rate of growth for some years to come, and it is therefore only necessary for us to further develop the network of service lines throughout our territory."

A budget that calls for more than $1,500,000 on new construction, improvements and replacements in 1932 by the Public Service Company of Colorado has been announced by Clare N. Stannard, vice-president and general manager. This covers an expenditure of $225,000 to reconstruct and enlarge the company's hydro-electric plant in Boulder Canyon; $175,000 to install a second coal-handling unit and cover other improvements at Valmont steam plant; and $750,000 for rebuilding, reinforcing and extending transmission and distribution lines and gas mains.

Right of an Industrial to Sell Surplus Power Without Becoming a Utility

By LESLIE CHILDS

WHERE a manufacturing company, operating its own electric light and power plant, develops more current than it requires it may find the sale of surplus current to near-by plants or individuals a source of profit. But the question of its right to do this, without becoming subject to regulation and control as a public utility, must always be considered.

As may be expected, this question has been the cause of much litigation and the holdings thereon are not in accord, since the outcome of each case has turned upon the particular facts involved. The extent of the service, the holding out of the company, express statutory provisions, and perhaps other features must be taken into consideration by the court.

However, by the weight of authority, in the absence of a statutory inhibition, a manufacturing company has the right to sell its surplus electric current, without subjecting itself to state regulation, so long as the service rendered is purely incidental to its main business. The application of this rule, and the reasoning upon which it is founded, may be illustrated by a review of the following decided case.[1]

Manufacturing Company Sells Surplus Current

Here, a manufacturing company, after installation of a power plant for its own use, found that it could produce considerable more current than it required. The company then proceeded to sell its surplus current to other concerns and persons who were located in the vicinity of its plant.

The company in some cases charged by meter, and in others a flat charge for the service was made. Any consumer desiring the service was required to make his own connection by wires and poles, and the company never at any time offered the service to the general public nor held itself out as serving all who might seek service.

The contracts for service were made privately with each consumer, and it was understood that the company was only offering to deliver its surplus current. The understanding being that at any time the company needed more current in its own business it could cease to furnish to outsiders, though there did not appear any express agreement governing the life of these contracts.

This state of affairs appears to have been satisfactory to all concerned until the company declined to continue to furnish current to a number of its customers. In refusing the service, it pointed out that it was not a public utility, was not incorporated to furnish electric current, and since it required the current for its own use it was within its rights in discontinuing the service.

Some of the users took action before the Public Service Commission to compel the company to continue the service. This action was based upon the contention that by engaging in the selling of electric current the concern was, in fact, a public utility, and as such was subject to regulation by the commission.

The commission held with the petitioners and granted the relief prayed for. The company appealed to the courts. The trial court reversed the order of the commission, and upon appeal the appellate court in affirming this judgment reasoned as follows:

"The operation of the electric light plant must of necessity be for a public use, and therefore be coupled with a public interest; otherwise the commission can have no authority whatever over it. The electric light plant must, in short, be devoted to a public use before it is subject to public regulation. We are not to be understood as saying that an electric plant constructed solely for private use could not, by professing public service, become by such profession, and by the furnishing of general public service, a public utility.

"There is in this case no explicit professing of public service, or undertaking to furnish lights or power to the whole public, or even to all persons in that restricted portion thereof who reside within three blocks of the company's plant; for there is in the case neither existence nor assertion of the right of eminent domain. . . .

"In the light of these considerations, does the business of the company constitute it a public utility, within the meaning of the Public Service Commission Act? We are of the opinion that it does not; for, as forecast above, state regulation of private property can be had only pursuant to the police power, which power is bottomed on and wholly dependent upon the devotion of private property to a public use. . . .

"Testing the facts of the instant case by this rule . . . we are constrained to hold that as to petitioners, the company owed them no continuing public duty of service . . ."

The foregoing case was carefully considered by the court and the holding announced appears to be in accord with the weight of authority, on the facts involved, this authority taking the position that in the absence of a statute to the contrary a manufacturing plant will not become a public utility by virtue of selling its surplus electric current to outsiders, where such sales are incidental, and there is no holding out to supply the public generally.

Of course, as stated by the court, this does not mean that such a plant could escape liability merely because it was in the first place constructed for private use. And, certainly if the service of supplying electric current ceased to become incidental, especially if coupled with an offer of service to all, even within a restricted area, such action would probably justify a contention that the plant was in fact a public utility and subject to regulation as such.

It is obvious that a manufacturing plant should approach the subject of disposing of its surplus electric current to outsiders with caution. If it can do this lawfully, without subjecting itself to regulation, the sale of current may prove a source of profit that otherwise would be lost.

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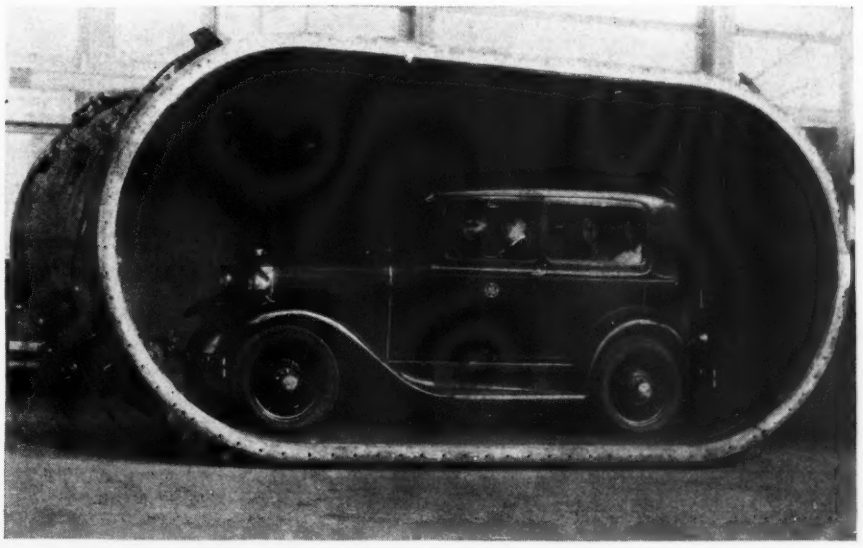

NOT A GARAGE—But the casing of a 50,000-kva. transformer built at the Pittsfield Works of the General Electric Company for the Hell Gate station of the New York Edison Company. The automobile gives an idea of the transformer's size

[1]State v. Public Service Commission, Supreme Court of Missouri, 205 S.W. 36.

THE ENGINEER'S BOOKSHELF

The First History of Power

THE QUEST FOR POWER. *By Hugh P. and Margaret W. Vowles. Published by Chapman & Hall, Ltd., 11 Henrietta St., Covent Garden, London, W.C. 2, England; 1931. Cloth, 6x9 in.; 354 pages, fully illustrated. Price, 15 shillings.*

IT MUST BE TRUE, as Hendrik Willem Van Loon asserts, that above starvation level man's greatest interest is in his "fairy tales." Otherwise, it would be difficult to explain why for years voluminous histories have been written of every other form of human activity save engineering; and this despite the fact that what may be properly defined as engineering endeavor extends back into prehistoric times.

The specialized work of a few societies and groups gives evidence that the lack has long been appreciated. Yet, it remained for a lone British engineer and his wife to compile the first comprehensive history of power engineering, and basically of all engineering. No words are strong enough to express the commendation they deserve.

Written in clear, compact style, "The Quest for Power" traces man's efforts to attain mastery of material down through the ages to the present day. A vivid picture of the development of hand tools and the stupendous tasks man accomplished with these early crude implements is given in the first part. The second part begins with the coming of the steam age and describes the origin of all types of power generators, their improvement and application up to modern times and what may be expected of them in the future. Similarly, the third part deals with progress in the discovery, extraction and utilization of fuels and metals. The epilogue, covering the work of the World Power Conferences with its social and economic consequences, is a fitting finale.

No mere summary of contents, however, can possibly convey the full merit of this book; its balance, perspective and sustained interest. It must be read, and will be with profit and pleasure by all those intelligent enough to want more than "fairy tales."

Propeller Turbine Flow

ARBEITSTRÖMUNG EINER PROPELLERTURBINE (The Active Flow in Propeller Turbines). *By Dr.-Ing. Fritz Busmann. Forschungsheft 349 published by the VDI-Verlag, Dorotheenstr. 40, Berlin N.W. 7, Germany; 1931. Paper, 8x12 in.; 24 pages, 78 illustrations and 2 tables. Price, 5 marks.*

THE DESIGN of propeller turbines presents special difficulties in comparison with that of Francis wheels. The stream line theory, which assumes the existence of an infinite number of vanes, is not applicable on account of the large clear opening between propeller blades. Modern propeller theories are based principally on the mathematical computation of the flow through a series of aerofoils and on measurements with wings in air. An allied problem is the calculation of the inactive flow in the transition space between guide vanes and propeller.

The research described in this publication represents the first experimental investigation of the assumptions underlying these theories. The experiments were conducted with a propeller turbine. Pressure and velocity measurements were made above and below the propeller under nine different operating conditions. The propeller rotated in a cylindrical casing of glass, and it was thus possible to photograph the active current, which was made visible by means of tiny wooden shavings.

Results of this research permit an exact determination of each of the most important hydraulic losses in the turbine. The investigation of the inactive flow in the transition space between guide vanes and propeller blades revealed deviations from potential flow, which were sometimes considerable. The meridian flow at the entrance to the turbine is by no means uniform; near the hub the velocity is often much greater than it is elsewhere. The meridian flow is affected by the circumferential flow, which is only approximately analogous to a potential vortex. As the gate opening decreases, forced vortices of increasing strength form in the circumstantial current. The cause of these vortices was investigated by means of special experiments with the wheel out of the casing.

Our Economic Future

WAGES AND THE ROAD AHEAD. *By James D. Mooney, president of the General Motors Export Corporation. Published by Longmans, Green & Company, 55 Fifth Ave., New York City; 1931. Cloth, 5½x8 in.; 149 pages. Price, $2.*

THE ABOLITION OF POVERTY. *By Harrison E. Fryberger. Published by the Advance Publishing Company, 3701 Chrysler Building, New York City; 1931. Cloth, 5x7½ in.; 152 pages. Price, $1.50.*

WITH A GRAPHIC DESCRIPTION of the inflationary period—its fake values and ideas as to sources of wealth, and its final collapse resulting in economic chaos—as a background, Mr. Mooney makes a plea for nation-wide reduction of wage rates as a way out of the present crisis.

Unfortunately, he adds little that is new to substantiate his solution. Arguments for low wages have been advanced before by employers in times of depression as a valid means of balancing production costs with falling consumption rates and reduced revenues. In brief the argument is that if wages are reduced prices can be lowered, goods can be moved and the factory wheels will hum again. Essentially simple, perhaps too simple.

Commodity prices, however, during the past two years have dropped 15 to 20 per cent without a material improvement in consumption.

In "The Abolition of Poverty" Mr. Fryberger attacks the problem from a radically different point of view. He discusses rather vehemently the defects in our economic structure and proposes a more equitable distribution of wealth as the cure for present ills.

The book is largely controversial in character, and one might hastily assume that the author leans toward the Soviet brand of communism if it were not for his frequent assurances to the contrary. What is more probable is that he inclines toward the growing belief that the economic system of the future will be a compromise between our present capitalism and the socialism of Marx and Stalin.

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RECENT REPORT published by the National Electric Light Association, 420 Lexington Ave., New York City, include: No. 162, "Acceptance Inspection and Testing of Cable," price. 30c.; No. 160, "Cable Research," price 25c.; No. 161, "Cable Operation—1930," price 40c.; No. 22, "Steel Strip and Sheet Annealing in the Electric Furnace With Atmosphere Control," price 40c.; No. 166, "Electric Water Heating," price $1.75; No. 21, "Casualty Insurance for Gas and Electric Utilities," price 25c.; No. 158, "Outdoor Substation Illumination," price $1.50; and No. 169, "Performance of Insulating Oils in Circuit Breakers," price 60c.

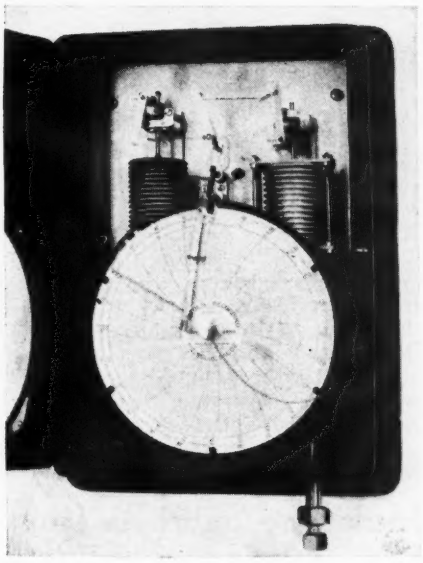
TECHNICAL PAPERS recently issued in printed form by the Institute of Fuel, 53 Victoria St., London, S.W.1, England, include: "The Measurement of Smoke," by J. Fraser Shaw; "The Collection and Treatment of Washery Slurry," by L. W. Needham; and "The Commercial Evaluation of Coke," by R. A. Mott. *Transactions* of the A.S.M.E., 29 West 39th St., New York City, for September-December, 1931 (Vol. 53—No. 15—Applied Mechanics), contains the following papers of interest to power engineers: "Strength of Materials Subjected to Shear at High Temperatures," F. L. Everett; "Thermal Stresses in Thin-Walled Cylinders," C. H. Kent; "Jets From Manifold Tubes," Jakob Kunz; "Strength of Thin Cylindrical Shells Under External Pressure," H. E. Saunders and D. F. Windenburg; "The Collapsing Strength of Steel Tubes," T. M. Jasper and J. W. W. Sullivan.

WHAT'S NEW IN PLANT EQUIPMENT

Two- and Four-Cylinder Industrial Air Compressors

THE LINE of industrial compressors, known as Model C, recently announced by the Curtis Pneumatic Machinery Company, St. Louis, Mo., consists of seven models, five of the two-cylinder type ranging in size from $4\frac{1}{4}$ x $3\frac{3}{4}$ to $6\frac{1}{2}$ x 5, with a displacement of 25 cu.ft. to 125 cu.ft., and two of the four-cylinder type, a $5\frac{1}{2}$ x $5\frac{1}{4}$ and a $6\frac{1}{2}$ x $5\frac{1}{4}$ size, with a displacement of 115 cu.ft. to 262 cu.ft. The compressors are available as stationary simple compressors for belt drive from a lineshaft, separate motor, steam engine or other prime mover, also as complete self-contained units, either direct connected or driven by multiple V-belt. They are likewise supplied with support wings instead of base mounting, in portable units.

The valves are of the light disk type, of rust-resisting metal with large non-obstructed ports, and are said to be carbon-free. The carbon-free feature is accomplished by designing the head so that the air is delivered into the cylinder at the lowest possible temperature, and maintaining the piston and cylinder walls at a minimum temperature. This low air temperature, it is claimed, is assured by having large-diameter, short intake passages, large ports and straight-line air flow. Carbon formation on the valves is further overcome because neither the crankshaft counterweights nor connecting rods ever touch the bath of oil. As a result the oil in the crankcase is not beat up into a foam or froth and cannot flood the cylinders. The crankshaft is mounted on roller bearings, and the oiling is provided for by the "Centro-ring" oiling method. A large-diameter ring operating at slow peripheral speed carries oil to the crankshaft midway between the bearings, from where it is delivered by centrifugal force through large oil ducts to each throw. The large steel ring is the only moving part of the oiling system.



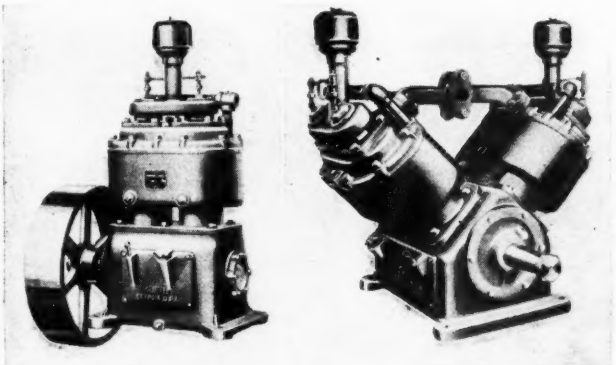
Bristol absolute pressure gage

Recording Absolute Pressure Gage

A DIRECT-READING, single-pen absolute pressure gage designed to obviate the necessity of applying barometric corrections to vacuum readings in connection with operation of turbine condensers, vacuum pans in sugar drying, vacuum oil stills and similar uses has been developed by the Bristol Company, Waterbury, Conn.

The actuating mechanism consists of two extremely sensitive diaphragm elements. One is connected to the vacuum line, and the other is directly affected by barometric pressure variations. The resulting movements of these elements are transmitted by a differential linkage to a single penarm.

The instrument can be furnished for ranges as low as from 0 to 50 mm. (0 to 2 in.) head of mercury pressure absolute or equivalent and is available for surface or flush mounting.



Model C air compressors in two- and four-cylinder types

Standard Drive Unit for Screw-Type Underfeed Stokers

A NEW variable-speed stoker drive produced by Link-Belt Company, 910 South Michigan Ave., Chicago, Ill., is now available as a standardized drive unit for underfeed screw-type stokers. The drive unit is a compact speed-reducing transmission, made in various sizes for stokers ranging from 50 to 1,250 lb. per hour of coal feeding capacity. Gear ratios can be provided to accommodate standard motor speeds of 1,160, 1,430 or 1,750 revolutions per minute.

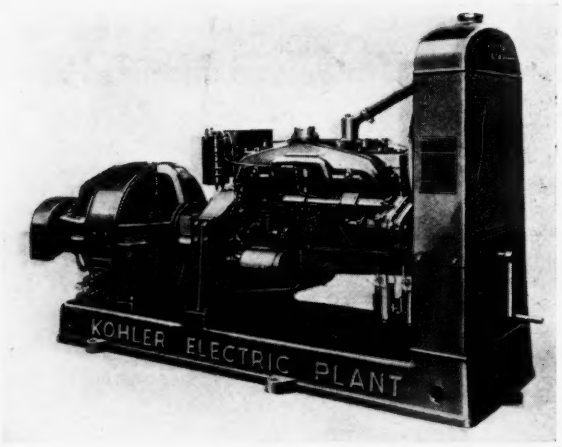
First reduction in speed is through a worm and gear set, consisting of a hardened and ground alloy steel worm and a cut bronze gear, with shafts mounted in oversize anti-friction bearings. Final reduction is through the medium of a three-speed adjustable ratchet, with overload shear pin hub, and full floating low-speed shaft. The entire worm gear and ratchet mechanism is fully inclosed, running in a bath of oil automatically circulated to the bearings Ratchet pawl mountings are designed for quiet, positive operation. Speed changes are made through a single lever which may be shifted while the gears and ratchet are in motion.

Link-Belt variable-speed stoker drive with cover removed to show ratchet and change-speed mechanism

Portable Automatic Power and Light Units

TWO NEW portable, automatic power and light units of 20 kw. direct-current and 25 kva. alternating-current capacity are announced by the Kohler Company, Kohler, Wis. The new plants have been developed for emergency installation on large ships and barges, and power and light in small communities where centralized current can be used, and similar locations.

The new plants are powered by six-cylinder heavy-duty industrial engines of the L-head type, with removable cylinder heads. An extra-heavy crank-



A 25-kva. Kohler power and light unit for stand-by and general service

shaft is supported by seven main bearings and full pressure oiling is used to all engine bearings. Cooling is by means of a large-size radiator and water circulation pump. The radiator fan is driven by double V-belts.

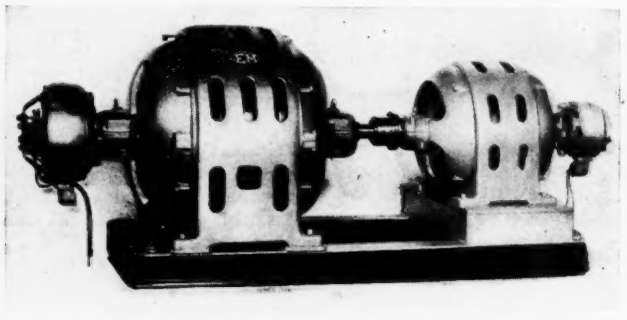
The starting system of the new plants, 12 volts, is controlled by a special relay system in order that the unit may be started and stopped by the closing or opening of a two-wire starting circuit. The plant will start and will continue to run as long as this circuit is closed. The starting battery is kept charged automatically by a generator mounted on the side of the engine. Standard 110- or 220-volt generators, both alternating-current and direct-current, can be furnished.

Frequency-Changer Sets for Industrial Service

TO PROVIDE means of obtaining alternating current at frequencies either above or below those of the usual 60-cycle source, the Electric Machinery Manufacturing Company, Minneapolis, Minn., has developed a line of synchronous-motor-driven frequency changers.

In the set illustrated the motor is rated 50 hp. to operate on 60-cycle current at unity power factor. The alternator is rated 125 kva. to deliver 30-cycle current. As the power factor of the load on the alternator is often low, the latter is designed to carry 25 kw. at 20 per cent lagging power factor.

In order that the generator excitation may be varied without changing the motor excitation each machine is furnished with its own exciter, which is direct connected to the shaft. If desired, the motor may be designed for leading power factor operation with more power factor corrective effect.

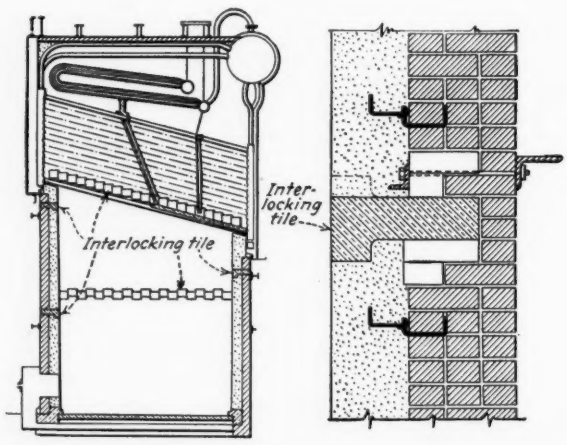


Synchronous-motor-driven frequency changer

Interlocking Corbel Tile for Supporting Furnace Linings

A NEW TYPE of interlocking corbel tile designed especially for use in connection with monolithic furnace linings is announced by Plibrico Jointless Firebrick Company, 1850 Kingsbury St., Chicago, Ill. The function of the tile is to support the firebrick alongside the tubes so that in replacing the lining there will be no possibility of the firebrick lining above the tubes falling down.

The right-hand view in the illustration shows the construction of sectionally supported wall incorporating the interlocking corbel tile. With this construction a monolithic wall may be divided into several independent sections, with each section supported by a row of tile. These tiles transfer the weight of the various sections to the exterior brick wall. The left-hand view shows a sectionally supported wall of a water-tube boiler. The tile are said to have a load bearing capacity of around 6,400 lb. each.



Sectionally supported monolithic furnace lining using interlocking Corbel tile

Small-Capacity Condensation Meters

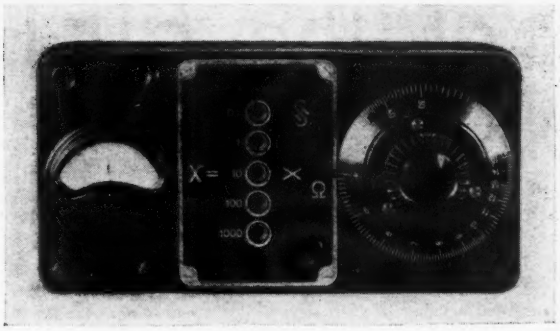
TWO SMALL SIZES, 250 lb. and 500 lb. an hour capacity, have recently been added to the line of Adsco rotary condensation meters put out by the American District Steam Company, North Tonawanda, N. Y. These new meters are similar in design to the larger rotary meters built for some years by the company.

Briefly, the meter is of the bucket type, containing six identical buckets locked in position at the rotor axis. As the buckets are filled, the weight of the condensate causes rotation, discharging the buckets and bringing empties successively into position for filling. The revolutions of the rotor are transmitted to the dial, which registers the measurement in pounds.

The meters are now available in a complete range of sizes and capacities from 250 to 6,000 lb. of water an hour.

Small Measuring Bridge

SMALL SIZE, light weight and simple operation are some of the advantages claimed for the S & H Type Z measuring bridge distributed by Herman H. Sticht & Company, 15 Park Row, New York, N. Y. The instrument, which is



In the Type Z measuring bridge current for operating is supplied by a battery contained within the casing

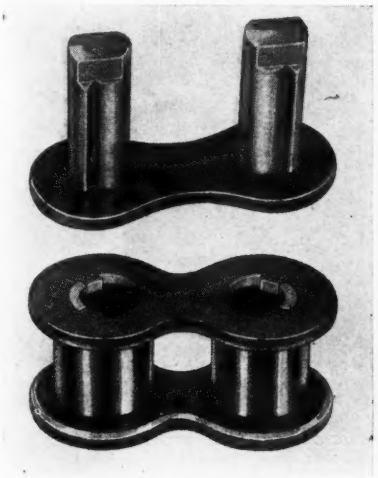
made in two sizes, 10,000 and 50,000 ohms, has small over-all dimensions of 9x4¾x2¾ in. and weighs about 3 pounds.

Current for operating the instrument is supplied from a battery contained within the casing; thus the instrument can be used where the required low voltage is not available. It can be used in either a horizontal or vertical position.

Roller Chain With New Joint Construction

A ROLLER CHAIN of distinctly different joint construction has been developed by the Morse Chain Company, Ithaca, N. Y. Within the roller there are two joint members, a segmental bushing and a pin. The cross-section of the pin is that of a round pin integral with a segmental bushing. Because of this construction, when a chain is flexing on or off a sprocket, all sliding movement of surfaces under load is between the pin and its bushing, and no movement occurs between the roller and the joint members when under load. This feature, it is claimed, insures uniformity of pitch throughout the life of the chain, and therefore smoother and quieter operation. The open spaces between the joint members provide reservoirs for oil.

The chain is made in single, double, triple and quadruple designs and is interchangeable on all standard roller sprockets.

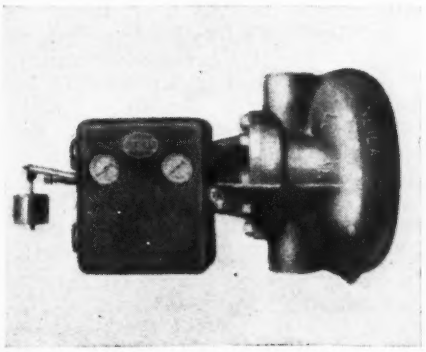


View showing link construction

Instrument-Type Liquid-Level Controller

AN INSTRUMENT-TYPE liquid-level controller designed especially for controlling the levels of liquids of high gravities is announced by Neilan Company, Ltd., 641-651 Santa Fe Ave., Los Angeles, Calif., Division of Mason Regulator Company. The controller is also applicable for interface service where the float is required to sink in one level and float in another of a different specific gravity.

In this controller only a 6-in. float is required to provide ample power for



Neilan liquid-level controller

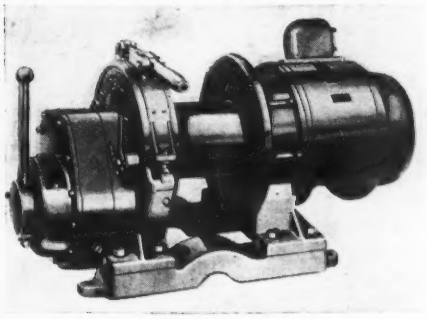
maintaining levels in liquids of even the highest gravities. The instrument is of the pilot-operated type and may be used to operate a remotely located control valve. It is also adapted to use in liquefied propane and butane.

Electric Portable Hoist

A RECENT addition to the line of portable hoists put out by the Ingersoll-Rand Company, 11 Broadway, New York, is the non-reversible, single-drum electric unit illustrated. It is modeled after the company's "Utility" hoists, except that it uses an electric motor and friction clutch instead of an air motor and jaw clutch.

The new hoist is suitable for all single cable work within its capacity, such as hoisting, pipe hauling and spotting cars, and for single-line scraping. It is made in two sizes. No. 107 is of 7½ hp. and rated 2,000 lb. pull at 125 ft. a minute, and with a drum capacity for 400 ft. of ½-in. or 700 ft. of ⅜-in. cable. No. 107L is of like power, but has drum capacity for 800 ft. of ½-in. or 1,400 ft. of ⅜-in. cable. No. 110 has a 10-hp. motor and is rated 2,000 lb. pull at 165 ft. a minute.

These new hoists have a self-energizing brake for stopping and holding the load and an automatic safety drum lock for added safety when handling suspended loads. Bases are drilled and grooved for either column mounting or bolting to a flat surface. Either alternating-current or direct-current motors can be furnished.



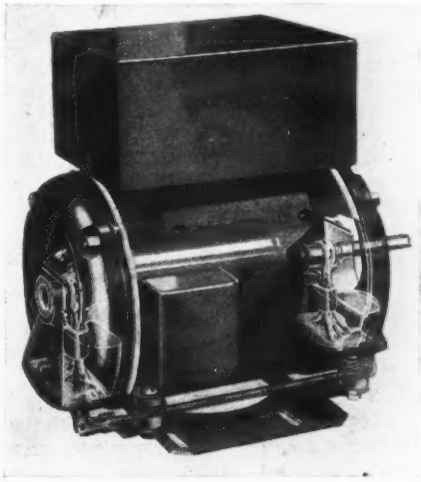
Single-drum electric portable hoist

Improved Oiling System on Small Motors

AUTOMATIC OILING is offered in connection with the small condenser-start induction-run motors now being put out by the Howell Electric Motors Company, Howell, Michigan.

This new motor has two oil wells, one for each bearing, each having a reserve capacity which is said to be sufficient to provide proper lubrication over a long period of time without adding new oil. The wells are connected together at the bottom by a pipe line, giving the advantage of one-point lubrication. The shape and design of the oiling system is such as to make it nonspillable no matter what position the motor is in.

Each sleeve bearing is wool-yarn-packed and has a wick running to the bottom of the well, which carries oil from the reserve supply to the bearing only as needed.



Bearing oil wells are connected together

NEWS of the FIELD

Satisfaction With A.S.M.E. Welding Code Reported by Pressure Vessel Manufacturers

GENERAL SATISFACTION with the A.S.M.E. code for the welding of pressure vessels, authorized last July, was expressed by several manufacturers in this field last Tuesday before a joint meeting of the metropolitan sections of the American Welding Society and American Society of Mechanical Engineers. The meeting, held in the Engineering Societies auditorium, was attended by several hundred engineers interested in pressure-vessel welding and related applications.

Some criticism of the code was also voiced, but this was distinctly subordinated to expressions indicating that the code as a whole is well adapted to the practical requirements of pressure vessel manufacturers, and particularly manufacturers of boiler drums and other severe service pressure vessels rated Class-I by the code.

Papers dealing with the code were presented by A. J. Moses, plant engineer of the Hedges-Walsh-Weidener division, Combustion Engineering Corporation, and by F. G. Sherbondy, vice-president, Biggs Boiler Works. Dealing less directly with the code, a paper by J. C. Lincoln, of the Lincoln Electric Company, discussed methods of producing ductile welds, and particularly the use of coated electrodes and the shielded arc.

James Partington, manager of the engineering department, American Locomotive Company, presided.

The attitude of Hedges-Walsh-Wiedener, as outlined by Mr. Moses, was of particular interest in view of the history of the welding code. In the discussions—during 1930 and 1931—which smoothed the way to the adoption of a code, the chief differences of opinion centered around the requirements for overall stress relief of Class-I vessels by heating to 1,100 or 1,200 deg., and also on the requirement of X-ray inspection. Some manufacturers, particularly those with smaller shops, felt that the first and operating cost of the required equipment was an unnecessary burden. Others expressed a definite willingness to use these precautions.

Mr. Moses' company, after considerable experimentation, aligned itself definitely with the latter group.

The welding process finally adopted by Hedges-Walsh-Weidener uses the metallic arc with coated electrode. An inspection agency is employed to supervise the inspection. Extensive training is given the welders, and they are severely tested before being allowed to weld on commercial pressure vessels. In addition, attached samples are welded with every vessel and boiler drum produced.

Mr. Sherbondy was not so fully in agreement with the code requirements as Mr. Moses. In particular, he would have preferred elimination of the requirement for general stress release, but considered it a necessary compromise to insure passage of the code. Mr. Sherbondy's paper stressed the economic side, urging engineers not to place artificial burdens on industry by insisting on a higher class of welding than properly required for the given work.

Mr. Lincoln's paper described the present form of the electronic tornado welder, which includes a paper-like strip fed continuously to the arc. Volatilization of this strip blankets the arc with a reducing atmosphere and improves the quality of the weld, according to Mr. Lincoln. The paper strongly urged the use of coated electrodes for all metallic arc welding, not only for much better quality of weld, but also for reduced cost due to higher speed of operation.

E. R. Fish of the Hartford Steam Boiler Inspection & Insurance Company, outlined the years of welding investigations by his company, and said that few manufacturers in the early days could meet their welding requirements. He exhibited some examples of bad welding, but said that good welding could be assured by proper control and testing. Mr. Fish insisted that stress release is highly important, and spoke of X-ray inspection as very desirable, although not showing up all defects.

Roosevelt Urges Bill to Create Utility Districts

GOVERNOR FRANKLIN D. ROOSEVELT, on the subject of water power, in his annual message, Jan. 6, to the New York State Legislature, said:

"The Power Authority, created last year, has made definite progress in the performance of the duties imposed upon it by law not only in working out the respective rights and interests of the four parties principally concerned, namely, the United States, Canada,

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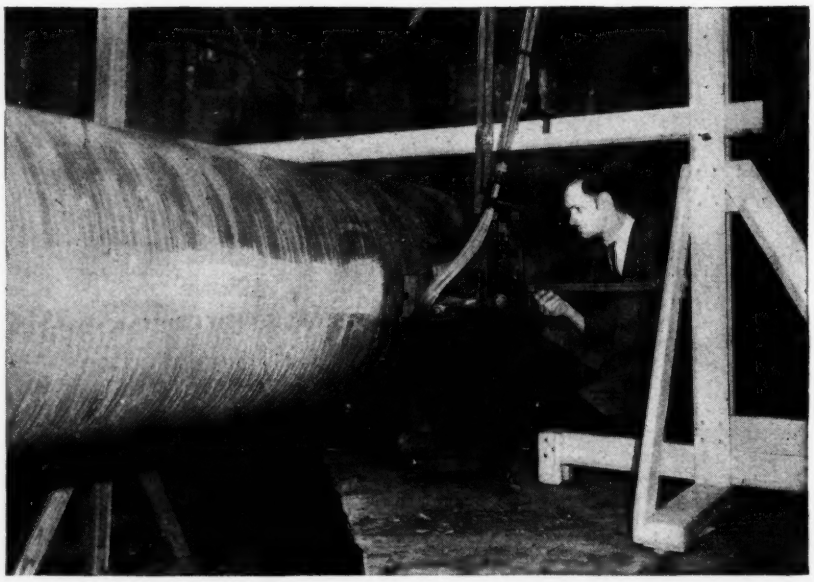
X-RAY CHECKS MERCURY PLANT PARTS



The new X-ray laboratory of the General Electric plant at Schenectady has been set to work examining the metal parts for the new mercury turbine power station soon to be erected there. The illustration shows the X-ray tube being set up for a photograph through four inches of metal

Province of Ontario, and State of New York, but also in a further study of the economic and engineering problems and in negotiations of contracts for power distribution.

"In conjunction with the mandate placed upon it by Section 5 of Chapter 772 of the laws of 1931, directing it to provide a reasonable share of the power to be generated on the St. Lawrence for the use of municipalities and other political subdivisions of the state now or hereafter authorized by law to engage in the distribution of electricity, I desire to recommend to your Honorable Bodies the adoption of a statute similar to the one which was proposed by me last year, but which failed of adoption, authorizing municipalities of the state to form public utility districts, with the consent of their voters, for the purpose of generating, distributing and selling electricity."

Jobs Found for 600 Engineers; Relief Fund Reaches $70,000

ENGINEERS are thinning the ranks of their unemployed in the New York area. Jobs have been found for nearly 50 per cent of the 1,200 men who have registered at the work bureau in the Engineering Societies' Building, it is announced by H. de B. Parsons, chairman of the Professional Engineers' Committee on Unemployment.

It is estimated that by the latter part of February 90 per cent of the registrants will have obtained part or full time work. Government projects and various engineering studies, now being rushed through preliminary stages, will provide jobs for several hundred. Branch job agencies have been opened in Newark, N. J.; Bronxville, in Westchester County, and Lynbrook, in Nassau County.

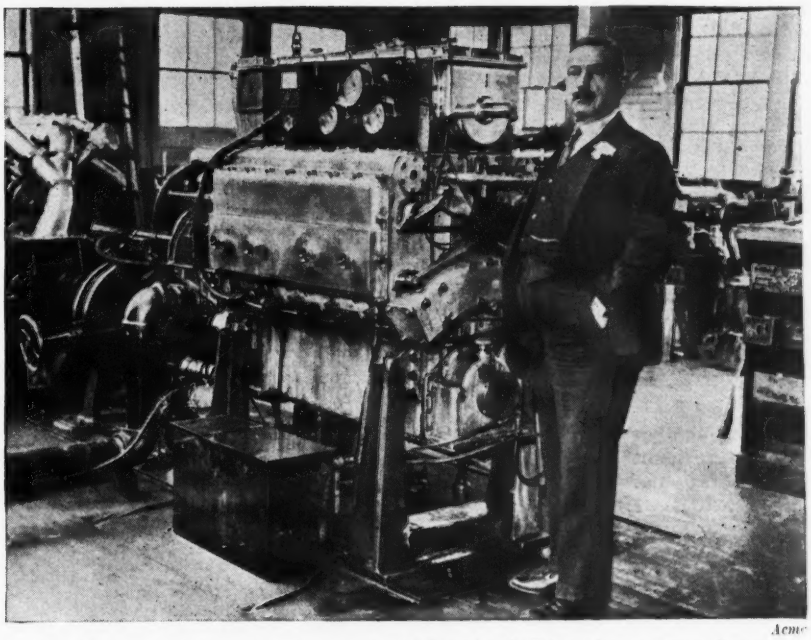
Financial distress in the profession is also being overcome, Mr. Parsons reported. Cash contributions of nearly $70,000, in addition to pledges of several thousands, have been received. Among the larger contributors was President Hoover, who gave $5,000 and promised more if necessary, and the Engineers' Club of New York, which contributed $2,500. To carry out its relief program, $200,000 is sought by the committee.

Washington Cities May Sell Surplus Power, Court Holds

THROUGH A RECENT DECISION of the State Supreme Court, corporate cities of Washington have the right to sell at wholesale their surplus municipal power to other towns. The court's decision denied an appeal of the Bremerton Municipal League. Through J. W. Bryan, of Bremerton, and Fred W. Bandy, of Tacoma, the league sought an injunction to restrain Bremerton from entering into contract for purchase of the city of Tacoma's surplus power. Tacoma, Seattle, Bremerton, Centralia and Puyallup all were concerned in the opinion, as each city proposed to buy or sell surplus power. Tacoma and Centralia have proposed to exchange surplus energy. Bremerton and Puyallup have taken steps toward construction of municipal power plants, the opinion said.

Messrs. Bandy and Bryan complained that such acts were beyond the corporate powers of cities of the first class. The court held their contentions were true insofar as concerned normal power development, but did not hold that surplus energy also must not be sold.

NEW TYPE DIESEL ENGINE DEVELOPED



Acme

F. B. Stearns, automobile engine expert of Cleveland, Ohio, demonstrates the new type diesel engine he has developed as the result of twelve years' research work. It is a diamond-shaped machine with eight cylinders and sixteen pistons. Except for the crankshaft, the engine is made entirely of aluminum and aluminum alloy. It weighs 2,000 lb. and develops 160 horsepower

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British Institute of Metals Postpones American Meeting

IN VIEW of the disturbed economic and financial conditions that prevail in Europe and America the council of the Institute of Metals has found it necessary to postpone the 1932 American meeting which was to have been held in the United States and Canada next fall. The meeting had been planned with the close cooperation as prospective hosts of the American Institute of Mining and Metallurgical Engineers.

The council's suggestion that the meeting be postponed was sympathetically received in America and the assurance has been made that the members will be welcome at such later time as may suit their convenience.

An announcement regarding the institute's place of meeting next autumn will shortly be made.

Portland (Ore.) Organizes to Help Unemployed Engineers

FINANCIAL RELIEF for unemployed engineers in distress and jobs for such of them as can be placed are the principal objects of organization machinery set in motion in Portland, Ore., by the Oregon Technical Council last week. The council is composed of representatives of all the engineering groups and its machinery has been set up to take care of all classes of engineers in lieu of having separate plans for each group. The action of the council to date was ratified and authority was granted to proceed with further organization details at a joint meeting of the executive committees of all the local sections of the founders societies, Dec. 22, at which O. L. LeFever, president of the council, presided.

The plan contemplates taking subscriptions from employed engineers monthly for six months, adding to this such funds as can be raised elsewhere and thus creating a fund to loan to needy unemployed engineers at 4 per cent interest. It is expected that these loans will be repaid and proportionate returns made to subscribers.

The committee to raise the funds consists of E. B. McNaughton, First National Bank; O. B. Coldwell, vice-president and general manager, Portland General Electric Company; and A. S. Moody, Northwest manager, General Electric Company. An eligibility committee will pass on the loans and a third committee is charged with coordinating the employment of engineers during the emergency.

Capt. McAllister, Head of Shipping Bureau, Dies

CAPT. CHARLES A. MCALLISTER, president of the American Bureau of Shipping and former engineer-in-chief of the United States Coast Guard Service, died Jan. 6 at his home in New York City following an attack of indigestion.

Born in Dorchester, N. J., on May 29, 1867, Captain McAllister spent his early years at City Island, where his father operated a shipyard. He entered Cornell University on a scholarship and was graduated in 1887 as a mechanical engineer. Soon after he joined the old United States Revenue Cutter Service, forerunner of the present Coast Guard, and won rapid promotion. When he retired from the service in 1919 to become vice-president of the American Bureau of Shipping, he held the post of engineer-in-chief. He became president of the bureau in 1926.

Captain McAllister was one of the early leaders who advocated a strong American merchant marine and did much to aid in the enactment of the present shipping laws. As chairman of the Fuel Conservation Committee of the United States Shipping Board, he was active in experiments to increase the efficiency of marine power installations through the use of pulverized coal.

He was vice-president of the Society of Naval Architects and Marine Engineers; a trustee of the Webb Institute of Naval Architecture and the American Merchant Marine Library Association; associate member of the United States Naval Institute; and a member of the Engineers Club.

Coeur D'Alene to Vote on Municipal Plant Proposal

JAN 19 HAS BEEN SET by the City Council of Coeur D'Alene, Idaho, as the date of a special election at which the voters will be asked to ratify certain ordinances recently passed by the council empowering it to create a sinking fund and float a bond issue to make possible the purchase or construction of public utility plants.

There has been more or less agitation for municipal ownership in Coeur D'Alene prevalent during the past year. Its origin is attributed to a law suit centering about the sale of the Coeur D'Alene light and power and water systems then owned by the Paulsen-Day-Easton interests, to the Washington Water Power Company. Testimony brought out facts which led the residents of Coeur D'Alene to believe that the companies were making too large a profit at their expense, about 12 per cent., it was contended, instead of the 8 per cent permitted by law. Following the 1931 spring election, in which municipal ownership was the main issue, the successful candidates elected on this ticket engaged an engineer to make a survey and recommendations. Although this report has not been made public, it is understood that his recommendations were favorable and the costs he estimated as between $600,000 and $650,000 for both light and power plant and water system.

As, under the Idaho law, condemnation of existing private utilities is not possible, the pursuance of a municipal ownership policy by the City of Coeur D'Alene would mean that the community either would have to build new plants to compete with the Washington Water Power Company or else they must buy the existing plants.

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COMING CONVENTIONS

American Society of Mechanical Engineers. Spring meeting at Bigwin Inn, Lake of Bays, Ont., Canada, June 27-July 1. Secretary, Calvin W. Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. Annual winter convention in New York City, Jan. 25-29. Secretary, F. L. Hutchinson, 33 West 39th St., New York.

American Society of Heating and Ventilating Engineers. Annual meeting and exposition, Hotel Statler, Cleveland, Ohio, Jan. 25-29. Secretary, A. V. Hutchinson, 51 Madison Ave., New York City.

American Society of Refrigerating Engineers. Joint meeting with the A.S.H.V.E. and annual convention at the Hotel Cleveland, Cleveland, Ohio, Jan. 26-29. Secretary, David L. Fiske, 37 West 39th St., New York City.

American Society for Testing Materials. Annual meeting at Chalfonte-Haddon Hall, Atlantic City, N. J., June 20-24. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Water Works Association. Annual convention at the Hotel Peabody, Memphis, Tenn., May 2-6. Secretary, Beekman C. Little, 29 West 39th St., New York City.

Engineering Institute of Canada. Annual meeting at the Royal York Hotel, Toronto, Ont., Feb. 3-5. Secretary, R. J. Durley, 2050 Mansfield St., Montreal, Que.

National Marine Engineers Beneficial Association. Annual convention at the Hotel Jefferson, St. Louis, Mo., Feb. 8-12. Secretary-Treasurer, Albert L. Jones, 313 Machinists' Building, Washington, D. C.

National Electric Light Association. Annual convention in the Atlantic City Auditorium and Convention Hall, Atlantic City, N. J., June 6-10. Secretary, A. Jackson Marshall, 420 Lexington Ave., New York City.

SECTION MEETINGS

A.S.M.E., Metropolitan Section. Fuels Division meeting in Room 502, Engineering Societies Building, Jan. 19 at 8 p.m. Subjects: "Responsibility of Mechanical Engineers in Smoke Abatement," Col. E. H. Whitlock, and "Discussion of Smoke Abatement From Health Standpoint," Dr. A. Blauvelt.

A.S.M.E., Mid-Continent Section. Meeting at the University Club, Tulsa, Okla., Jan. 15 at 9 a.m. Subject: "Production of Unfired Pressure Vessels," D. L. Trax, W. A. Carson and G. Raymond.

A.S.M.E., Schenectady Section. Meeting in Edison Club Hall, Jan. 21 at 8 p.m. Subject: "Vertical Transportation," Bassett Jones.

Sign Last Five Contracts For Hoover Dam Power

SECRETARY OF THE INTERIOR, Ray Lyman Wilbur, has just signed five contracts for Hoover Dam power, the last to be executed under the allocation made in April, 1930, until such time as the states of Arizona and Nevada wish to contract for energy.

These contracts are with the municipalities of Pasadena, Glendale and Burbank, Calif., with the Southern Sierras Power Company and the Los Angeles Gas & Electric Corporation. The allocation of April, 1930 gave 6 per cent to eleven municipalities, to be divided as they might agree before Nov. 16, 1931, as well as 13 per cent to the City of Los Angeles. Only 3 of these municipalities, Pasadena, Glendale and Burbank elected to contract, and each of them receives all that they ultimately applied for. It was provided that so much energy as the municipalities did not take should go to the City of Los Angeles. The three municipalities contracting took 4 per cent. Los Angeles is obligated for the balance under its contract, raising its allocation about 15 per cent. The same allocation gave 9 per cent to four public utilities serving the area outside the contracting municipalities, to be divided as they might agree before No. 16, 1931. One of them dropped out, leaving the Southern California Edison Company with an allocation under this agreement of about 7.2 per cent, and each of the others with 0.9 of 1 per cent.

About $25,000,000 will be collected under these five contracts over a 50-year period if the present rate of 1.63 mills per kilowott-hour is maintained. That rate is subject to readjustment periodically under the terms of the Boulder Canyon Project Act.

Los Angeles Power Board Keeps City Loan for System

A REQUEST of the Southern California division of the President's Organization for Unemployment Relief that $3,000,000 loaned by the City of Los Angeles, Calif., to the water and power board be returned to the city's general fund at this time to be used in speeding up unemployment relief, has been refused by the board of water and power commissioners.

After considering the matter in special meeting, the board in open session adopted a prepared resolution, the gist of which was that the request could not be complied with without crippling the power system of the Department of Water and Power. An accompanying statement pointed out that the board has rendered assistance in every way to relieve unemployment by advancing money to the city's general fund to avoid a tax increase, without which the tax rate would have been 4 or 5 cents.

Personals

EVERETT S. LEE, an assistant engineer in the general engineering laboratory of the General Electric Company at Schenectady, has been appointed engineer in charge of the laboratory to succeed the late LEWIS T. ROBINSON. Mr. Lee joined the company in 1913 and then went to Union College as an instructor in electrical engineering. After the World War, he entered the G. E. laboratory and was made an assistant engineer in 1928. DR. J. J. SMITH has been appointed to succeed Mr. Lee as one of the assistant engineers.

ALBERT H. MYERS, who was for several years executive engineer of the Wellman Engineering Company, Cleveland, and for the past five years district representative of Stone & Webster, Inc., in the Milwauwkee district, has established a literature research service for architects, engineers and patent attorneys. Mr. Myers is at present making his headquarters at 3201 West National Ave., Milwaukee, Wis.

GEORGE C. WARD, executive vice-president of the Southern California Edison Company, under whose direction large hydro-electric and steam-plant developments of the company have been completed, was recently made senior vice-president. Other promotions in the company include the advancement of WILLIAM C. MULLENDORE, vice-president, to the post of executive vice-president, and FRED B. LEWIS, vice-president and assistant general manager, to the position of vice-president and general manager.

SAMUEL INSULL, JR., president of the Midland United Company, Chicago, was elected vice-chairman at a recent meeting of the board of directors. ROBERT M. FEUSTEL, executive vice-president of the company and chief operating head of the subsidiaries, was elected president to succeed Mr. Insull, and WILLIAM A. SAUER, who has been vice-president and general manager, was elected executive vice-president.

JOHN E. BARKLE has been appointed general manager of the South Philadelphia works of the Westinghouse Electric & Manufacturing Company. Mr. Barkle, who entered the employ of the company in 1901, was formerly works manager at South Philadelphia, and previous to that superintendent of manufacturing of all generating apparatus at East Pittsburgh.

GEORGE R. PRATT has re-established himself in Winnipeg, Man., in private practice as consulting steam-power and combustion engineer. Recently he completed a two-year engagement with the United Engineers & Constructors, Montreal, as assistant designing engineer on the Glace Bay (N. S.) plant of the Dominion Coal & Steel Company, and a similar power plant erected at Minto, N. B., for the New Brunswick Power Commission.

How's Business?

ACCELERATED ACTION by Congress on the Reconstruction Finance Corporation in response to public and presidential pressure, reassuring rumors of better agreement between Britain and France as the reparations conference approaches, early evidence of fairly vigorous reinvestment demand in security markets, and a general lull in output of bad news have helped to lend a more hopeful color to the first week of the new year. Statistical records covering the holiday weeks are of no special significance except as indicating the extreme and expected slackness of year-end activity. Still there is distinct encouragement in commodity prices, well sustained levels of power production and carloadings, and recent signs that the usual seasonal rise in steel production is not going to be delayed despite uncertainties of prices and of demand from principal consuming industries.—*The Business Week,* Jan. 13.

Business Notes

STONE & WEBSTER ENGINEERING CORPORATION, Boston, Mass., announces the removal of its Seattle (Wash.) office to 810 Skinner Building.

CROOKE, BURNETT & COMPANY, York, Pa., has been organized by Leonard Crooke and W. J. Burnett to offer a complete service for the design and manufacture of special machinery, foundry products and the fabrication of plate and structural steel.

GEARS AND FORGINGS, INC., Cleveland, Ohio, announces the appointment of the following new distributors of its products: Terra Haute Heavy Hardware Company, Terre Haute, Ind.; Ross-Willoughby Company, Columbus, Ohio; Koontz-Wagner Electric Company, South Bend, Ind.; Stambaugh-Thomson Company, Youngstown, Ohio; and Hardware & Supply Company, Akron, Ohio.

SHARPLES SPECIALTY COMPANY, Philadelphia, Pa., announces the appointment of Carl J. Lamb as New York district manager. Mr. Lamb was formerly with the Westinghouse Electric & Manufacturing Company in the service, engineering and sales departments.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, East Pittsburgh, Pa., and the Westinghouse Electric International Company announce that they have concluded with Eroole Marelli & Company in Milan, Italy, a leading Italian electric manufacturing concern, an agreement for an exchange of patents and experience. The Westinghouse companies, the announcement states, do not participate financially nor take any part in the management of the Italian company.

UNION IRON WORKS, Erie, Pa., has just issued an art calendar entitled "The Spirit of Leadership," featuring a verse composed in memory of Knute Rockne by the well-known sports writer, Grantland Rice, which it is distributing to those interested. The company is now installing four 4,050-sq.ft. boilers in the new power plant at Notre Dame University.

Trade Catalogs

AIR STARTING UNITS—Ingersoll-Rand Company, 11 Broadway, New York, N. Y., has issued a new illustrated bulletin (Form 1897) on "Air Starting Units for Internal Combustion Engines." The introduction briefly discusses the factors that enter into the selection of suitable machines of this class. Electric-, gasoline- and belt-driven compressors for this service are shown, together with diagrams and tables of dimensions for each unit. A formula is given for determining the time required to pump up a starting air tank to various pressures.

WELDING—The advantages and applications of the "Homoweld" for pressure and temperature equipment are discussed in Bulletin W-1 just issued by the Henry Vogt Machine Company, Louisville, Ky. Photomicrographs of welded specimens are shown, together with illustrations and descriptions of tensile, bend, fusion and hardness tests.

STEAM-LINE EQUIPMENT—American District Steam Company, North Tonawanda, N. Y., has just issued the 1932 illustrated catalog, covering its line of slip-type and packless expansion joints, underground steam conduit, insulation and accessories, condensation and steam-flow meters, water heaters, steam traps, separators, strainers and allied specialties for underground steam and hot-water lines.

CINDER CATCHER—The construction and operation of the "Vortex" cinder catcher are described in a new bulletin of Dust Recovery, Inc., 15 Park Row, New York, N. Y. Installations in operation are shown in the illustrations.

BUSINESS REPORTS—"How Exhibitors Are Meeting the Trade Show Problem" is the title of a comprehensive survey of trade exhibit practice among various associations and companies, which has just been issued by the Policyholders Service Bureau of the Metropolitan Life Insurance Company, 1 Madison Ave., New York, N. Y. The bureau has also issued a revised edition of its "Index of Economic Reports."

NEW PLANT CONSTRUCTION

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Sunnyvale—Bureau of Yards & Docks, Navy Department, Washington, D. C., receiving bids for a group of buildings including boiler plant, helium building, helium storage building, etc., at Naval Air Station here.

Conn., South Manchester—L. T. Wood, 51 Bissell St., awarded contract for construction of a 1 story, 62 x 125 ft. ice plant at Bissell St. and Johnson Terrace to Gustave Schrieber & Son, Inc., 285 West Center St. Estimated cost $75,000.

Ind., Indianapolis—Shell Petroleum Co., 2219 West Michigan St., awarded contract for construction of a pump house, including additional pumps, storage tanks, etc., to Krebay Construction Co., 802 New City Trust Bldg.

Ia., Iowa Falls—Central Electric Co., Dows Bldg., Cedar Rapids, awarded contract for construction of addition to power plant including a 7,500 kw. steam turbine and auxiliary equipment to Welden Construction Co., Iowa Falls.

Ia., Rochester — Iowa Power & Light Co., Cedar Rapids, plans construction of a dam on Cedar River near here. Estimated cost $1,000,000.

Mass., Boston—Commonwealth of Massachusetts, Metropolitan District Commission, awarded contract for furnishing and erecting two steam turbine driven centrifugal pumping units for Chestnut Hill pumping station No. 1 to Warren Steam Pump Co., 101 Milk St. $64,199.

Mass., Holyoke—Holyoke Water Power Co., plans extending dam and constructing power house and river wall, etc., on Connecticut River.

Michigan—Detroit Edison Co., 2000 Second St., Detroit, and 60 Broadway, New York, N. Y., plans to expend $9,000,000 during 1932 for electric power expansion and extensions.

Mich., Detroit — Detroit Edison Co., 2000 Second Blvd., plans complete construction of switch house for Connors Creek power plant on Lycaste Ave. Estimated cost $200,000. Part of 1932 expansion program.

N. Y., Astoria—Astoria Light, Heat & Power Co., 4 Irving Pl., New York, will build addition to generator house at Winthrop Ave. and Hallet St. here. Estimated cost to exceed $40,000 including equipment. Work will be done by day labor and separate contracts.

N. Y., Fair Haven—Lake Ontario Power Co., Sodus, has been granted permit by Public Service Commission to establish electric distribution system here. Work will be done by day labor and separate contracts.

N. Y., Little Falls — East Jefferson Street School, will soon readvertise for bids for construction of a new heating plant. Former bids rejected.

O., Easton—City Council, preparing plans for construction of municipal electric light plant. M. L. Reid is city engineer. George Champe & Associates, Nicholas Bldg., Toledo, are consulting engineers.

O., Lima—City Commissioners, F. C. Becker, City Mgr., will receive bids until January 11 for construction of a municipal electric light and power plant. Le Roy E. Miller is city engineer.

O., Lima — Ohio Power Co., 301 Cleveland Ave., plans construction of a sub-station at Hover Park section near solar plant of Standard Oil Co. of Ohio. Estimated cost $32,000. H. S. Sterling is district manager.

Pennsylvania and New Jersey—United Gas & Improvement Co., J. E. Zimmermann, Pres., 1401 Arch St., Philadelphia, Pa., and subsidiaries, plan expending $28,000,000 during 1932 for additions and plant equipment improvements in various locations in Pennsylvania and New Jersey. United Engineers & Constructors, Inc., 112 North Broad St., Philadelphia, subsidiary construction company.

Pa., Lancaster—City awarded contracts for Little Conestoga sewage pumping station, Cont. 41 to Vincenzo Di Francesco, Lianerch, Cont. 42 and 44 to D. S. Warfel Co., Lancaster. Cont. 43B to Conestoga Electric Co., Lancaster, and Cont. 45 to Frank George, 1657 Mahoning Ave., Youngstown, O. Total est. $57,540.

Pa., Philadelphia — American Ice Co., 121 North Broad St., awarded contract for construction of an ice manufacturing plant to Sutton & Stephenson, 1317 Washington Ave. Estimated cost $40,000.

R. I., Newport—City will build a sewage system (Sect. 2) to include two pumping stations, ejector station, etc. Estimated cost $186,000. Private plans. Work will be done by day labor.

Tennessee—Tennessee Electric Power Co., 540 Market St., Chattanooga, controlled by Commonwealth & Southern Corp., 20 Pine St., New York, N. Y., plans to expend $2,000,000 during 1932 for construction program here.

Tex., Houston—City plans construction of a hospital, nurses' home and power plant. Estimated cost $1,500,000. Joseph Finger and A. C. Finn, Houston, are architects.

Tex., San Antonio—San Antonio Public Service Co., 201 North St. Marys St., plans improvements to general system including underground conduits, transformers, gas lines, etc. Estimated cost $600,000. Private plans.

Ont., Woodstock—City awarded contract for construction of a pump house on Bexley St. to Thomas J. Bezley, 230 Wellington St. N. $15,000.

Equipment Wanted

Cranes—San Diego and Mare Island, Calif.—Bureau of Yards & Docks, Navy Dept., Washington, D. C., receiving bids for two 25 tons floating revolving boom cranes mounted on steel pontoons and operated by Diesel electric power, one for Navy Yard, Mare Island, and one for San Diego.

Pump—Philadelphia, Pa.—Bureau of Supplies & Accounts, Navy Dept., Washington, D. C., will receive bids until January 19 for one gasoline engine driven centrifugal pump, for Navy Yard here. Sch. 7206.

Pumps—Washington, D. C.—Bureau of Supplies & Accounts, Navy Department, will receive bids until January 19 for twenty-eight electric portable pumps and spares for east and west yards. Sch. 7170.

Pumps — Lansing, Mich. — City is receiving bids for one 900. one 1,200 and one 1,300 g.p.m. electric motor driven centrifugal pumps in connection with proposed waterworks improvements.

Pumps—Marquette, Mich.—City Council, J. F. Anderson, Purch. Agt., will soon receive bids for three new electric pumps to replace old steam pumps in connection with proposed waterworks improvements and power transmission line from municipal power plant to waterworks system. Estimated cost $50,000.

Transformers, etc.—Brooklyn, N. Y.—Signal Supply Officer, Army Base, will receive bids until January 12 for 100 transformers and 448 capacitors.

Turbine—Orrville, O.—Board of Control, plans to purchase a new steam turbine and auxiliary equipment in connection with municipal water and light plant. Estimated total cost $72,000.

Industrial Projects

Ariz., Phoenix — United Copper Mining & Paint Co. Ltd., c/o Frederick Beutel, Pres., 936 East 60th St., Los Angeles, Calif., plans construction of a copper paint manufacturing plant here. Estimated cost $50,000.

Conn., Forestville—Peter Persen c/o Forestville Manufacturing Co., had plans prepared for construction of a 1 story, 20 x 80 ft. factory to be equipped with automatic machinery.

Mich., River Rouge—Ford Motor Co., Schafer Road, Dearborn, preparing plans for construction of two electric sub-stations, one for steel plant and one for glass plant here. Estimated cost $75,000. Giffels & Vallet, 604 Marquette Bldg., Detroit, are engineers.

N. J., East Rutherford — East Rutherford Syringe Co., 75 Mozart St., having revised preliminary plans prepared for construction of a 2 story factory at 54 Mozart St. Estimated cost $50,000. J. T. Camlet, 26 Piaget Ave., Clifton, is architect.

N. J., Newark—Dooner & Smith Chemical Co., 374 Mulberry St., awarded contract for a 2 story addition to chemical plant at 264 New Jersey Railroad Ave., to Frank J. Berger, 230 Belmont Ave. Estimated cost $40,000.

N. J., Newark—Charles Jeffreys, 38 Liberty St., awarded contract for construction of a 2 story refinery to Levine Bros., 519 South 14th St. Estimated cost $40,000.

N. J., Newark—Alfred Peter, 207 Market St., Archt., receiving bids for construction of a 2 story refinery for owner, c/o architect. Estimated cost $40,000.

N. J., New Brunswick—Empire Box Corp., Coduise Ave., plans a 2 story addition to box factory. Estimated cost $40,000. Architect not selected.

N. J., Newark—Epple & Kahrs, 17 Washington St., Archts., receiving bids for addition and alterations to rubber factory on Alvin St. Estimated cost $40,000.

N. J., North Bergen—Commercial Gases Co. Inc., c/o North Jersey Industrial Terminal Co., 1827 Bergen Turnpike, awarded contract for construction of a 2 story acetylene gas manufacturing plant on 39th St. to Bonanno Bros., 1827 Bergen Turnpike. Estimated cost $40,000.

Tex., Rio Grande—Rio Grande Oil & Gas Co., will build an oil refinery. 350 bbl. daily capacity, by day labor. Estimated cost $75,000. May purchase machinery and equipment.

Chile, Santiago—State Department of Finance, plans government owned refinery or granting of concession with government interest.